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THE HOW AND THE WHY OF THE PORRO PRISM FIELD-GLASS.*

WORCESTER REED WARNER.

Six years ago the writer brought home from Germany a strange new kind of field-glass, called the Zeiss prism binocular, one of the first made, and among the earliest imported into this country. It looked like an eccentric and somewhat unlovely opera-glass, and persons casually handling it gasped to hear that it cost forty dollars. In the meantime, however, the public has grown used to seeing prism binoculars, and hardened, in a way, to their price, realizing that they are instruments of precision, to which all other kinds of field-glasses bear about the same relation as that of a cheap watch to a fine chronometer. Each has

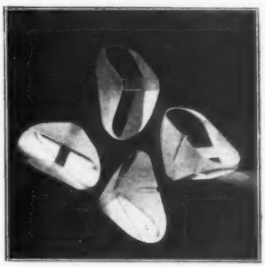


FIG. 1—PORRO PRISMS.

its place in the world; the costlier is to be accounted a luxury. But what the public has not yet come to wholly understand is the reason why the prism binocular gives its marvellous results. Since these insure its permanency and development beyond all peradventure, a simple analysis of the principles involved becomes an essential part of the average man's education, and is surely not to be overlooked by the engineers forming this Society, some of whom, doubtless, own and use the instrument without fully understanding the how and the why of it.

* Presented at the New York meeting (December 1901) of the American Society of Mechanical Engineers, and forming part of Vol. XXIII, of the *Transactions*.

The combination of prisms called by his name was invented about fifty years ago by the French engineer and optician Porro, to whom a patent was granted by Napoleon III. The principle of Porro's invention is illustrated by Fig. 2, where two prisms, each having one 90-degree angle and two 45-degree angles, are shown in their relative positions. A pencil of light or the image of an object passing through them is inverted.

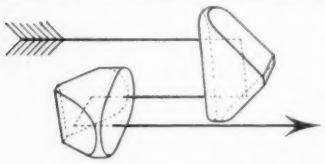


FIG. 2.—PATH OF LIGHT THROUGH PORRO PRISMS.

To follow the development of terrestrial telescopes and clearly make comparisons, we must illustrate by diagrams the principles governing the three common types of refracting telescopes together with the Porro prism telescope.

Fig. 3 shows a sectional view of the instrument known as the Galilean telescope, which is the same thing as our common field- or opera-glass.

In this telescope the rays of light collected by the object-glass are allowed to pass through a system of double concave lenses *before* reaching the focus, with the result that the converging

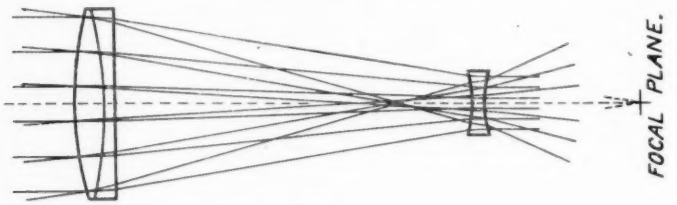


FIG. 3.—GALILEAN TELESCOPE (OPERA-GLASS.)

pencils of light gathered from the various parts of the field are made divergent as they emerge from the concave eye-lens ready to enter the eye. As this divergent cone of pencils of light is necessarily many times larger than the pupil of the eye, but a small part of the field gathered by the objective can be utilized; hence the very small field of view in all telescopes of this type. This limitation necessitates very low magnifying powers, the highest we find being but 6 diameters, while the usual power for Galilean field-glasses is but 4 or 5 diameters, and for opera-glasses but 2 or 3 diameters. which latter is generally considered sufficient for ordinary theatre use.

Fig. 4 illustrates the arrangement of lenses and the path of

light-rays in the type of terrestrial telescope commonly known as the "spy-glass."

The rays of light gathered by the object-glass reach their focus at the "focal plane," and back of this is the system of lenses forming the erecting eye-piece, from the eye-lens of which the pencil of light passes to the eye. In this type, also, the field of

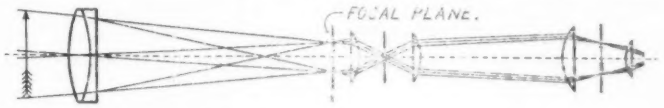


FIG. 4.—TERRESTRIAL TELESCOPE (SPY-GLASS).

view is necessarily so reduced as to make the use of the instrument very unsatisfactory. It must be quite long, too, and therefore very hard to hold steadily.

Our next illustration is the astronomical telescope shown in Fig. 5.

This is the most simple and most perfect of all. As in the other types, the object-glass gathers the light and sends it down toward the focus at the "focal plane," where it is taken by the simple astronomical eye-piece. Thence it emerges in a pencil of light smaller than the pupil of the eye, which, by using the same magnifying power as in the other types mentioned, is enabled to observe a field of view three times the diameter (nine times the area) shown in either of the instruments illustrated in Figs. 3 and 4. But in this instance the object is seen inverted. All astronomical telescopes show the object thus; which is all right for the stars, but will never do for terrestrial observation.

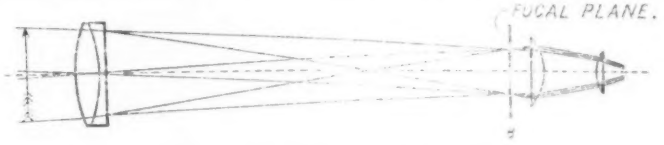


FIG. 5.—ASTRONOMICAL TELESCOPE.

Now, if we could erect the image of the object shown in the astronomical telescope, we should have the finest terrestrial telescope possible. This is just what is done by introducing the Porro prisms. The object is now shown with all the clearness, definition, and large field of the astronomical telescope, and in an erect position; and so the pretty problem is solved.

But there are several questions to be asked by the thoughtful man who handles one of these field-glasses. We may as well anticipate them and answer them in turn.

First: Just how do the prisms do their part?

The prisms serve a two-fold purpose, the first and most important being, as has been said, the erection of the object observed, and the second, the shortening of the telescope by twice turning the ray of light upon itself, so that the total length adjusted for use, whether for 6, 8, or 10 power, is but four inches, and the total weight, in binocular form, but thirteen ounces; so small and light, indeed, that it can easily be carried in the pocket.

Each triple barrel of the prism field-glass contains two double reflecting prisms, as shown in the diagram, Fig. 6.

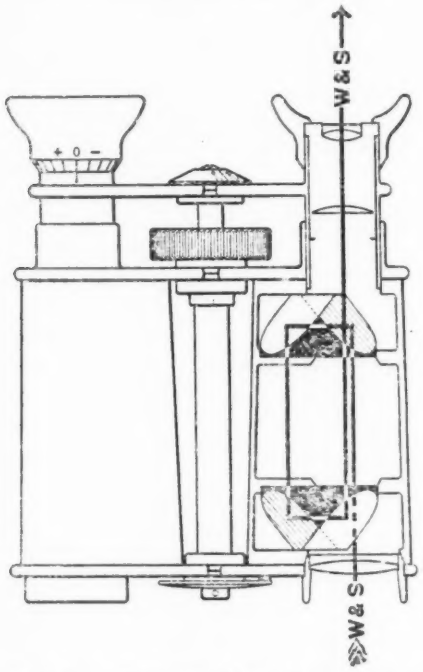


FIG. 6.—WARNER & SWASEY UNIVERSAL PRISM FIELD-GLASS (SECTIONAL VIEW.)

The rays of light passing through the object-glass enter the first prism in such a way as to be twice totally reflected, each time at an angle of 90 degrees, thus emerging parallel to the entering ray, but in the opposite direction. It is then caught by the second prism, and is similarly reflected and sent on its course toward the eye-piece, in its original direction without change, except in one very important particular; viz., the image of the

object observed, which without the intervention of the prisms would be upside down, is now erect, and is ready to be magnified by the simple astronomical eye-piece, just as the stars and planets are magnified in the largest telescopes.

Second: How can the field be so surprisingly large here, or why is the field shown by the old-time glasses so small? Let us try and get a correct comparison of the two types of telescope.

When observing with the Galilean telescope (opera-glass type), the axes of the pencils of light flowing from the several parts of the field gathered by the objective are divergent as they emerge from the concave eye-lens; and as they cover an area many times the size of the pupil of the eye, most of the light is lost; the field utilized is very small, and can be moved over an extended area by moving the eye about the eye-lens of the instrument, as when looking through a paper cone from the *larger* end.

The Porro prism field-glass is constructed on exactly the opposite principle. The axes of the pencils of light coming from the several parts of the field are concentrated by the convex lenses of the eye-piece, and emerge from the eye-lens in a pencil of light small enough to all enter the pupil of the eye, in the same natural manner as we observe with the unaided eye in looking through a paper cone from the *smaller* end, without strain or weariness to the eye, thus giving a large and uninterrupted field of view, three times the diameter (nine times the area) possible in the old style instrument of the same power, as shown by Figs. 7 and 8.

In the development of the prism binocular it has been found that the magnifying powers which may be most advantageously used range from 6 to 10 diameters. It is true that no one power is best for all purposes. A good average, however, is reached in the 6 and the 8 powers, which are those in most popular use. The uninitiated often make the mistake of thinking that the highest powers are most desirable, which is far from the fact. Any increase in power must be met by a decrease in field of view, by a diminution of light, and also by an increase in the effect of unsteadiness of the instrument while observing. The Porro prism glasses are so short that they can be better held than any other kind of terrestrial telescope, and therefore there is no practical difficulty in holding an 8-power with sufficient steadiness to make terrestrial observation successful. Any higher power than this is apt to cause annoyance from the reasons mentioned, while the 6-power (which is as high as any of the old-style Galilean field-glasses) is eminently satisfactory for natural history and general landscape observations, and the fact that its field is three

times as large as is possible in the Galilean telescope of the same power is enormously in its favor.

A few minutes' practice will enable one to quickly determine the power of any opera- or field-glass.

FIG. 7.—FIELD SHOWN BY THE BEST PRISM FIELD-GLASS.

Place the left eye-piece to the right eye, closing the left eye meanwhile, and carefully focus on a near object, preferably a window across the srreet. With this object clearly in view, open

FIG. 8.—FIELD SHOWN BY THE BEST OLD-STYLE FIELD-GLASS OF THE SAME POWER.

the left eye, when two images of the window will be evident—one magnified by the instrument and the other as seen by the unaided left eye. An instant's comparison will show how many times

longer and wider is the image shown by the telescope than the one viewed by the unaided eye. This ratio represents the power of the field-glass in diameters.

The magnifying power of the two field-glasses can readily be compared by observing an object with both at the same time, using one eye for each of the glasses tested.

The many special advantages possessed by the Porro prism field-glass early attracted the attention of Government officials throughout the world, and after searching investigation and severe tests these instruments have been very generally adopted for Government use. During the last year Germany ordered over six thousand of them, while England has sent as many or more

FIG. 9.—ZEISS PRISM FIELD-GLASS.

to South Africa; and in the various departments of our own Government they have become very popular and are rapidly taking the place of all other field-glasses. The fact that they give greater power and field, with better definition, and at the same time are but a fraction of the size of the old Galilean type, is a sufficient explanation of their popularity for Army and Navy use.

In view of the great advantages possessed by these instruments over all other terrestrial telescopes, why, you will ask, did the invention wait a half century before practical use was made of it? There are at least two adequate reasons:

First—The best optical glass manufactured at that time ab-

sorbed so much light as to render impracticable the successful use of Porro prisms made of it.

Second—Opticians have only within recent years known how to make absolutely flat surfaces, without which the object seen through the Porro prism telescope is distorted.

Both difficulties have been brilliantly conquered. The borosilicate glass made by Mantois of Paris and Schott of Jena, and which is exclusively used for these prisms, is so nearly perfect that but 4 per cent of light passing through it is lost by absorption. Moreover, optically flat surfaces are now made correct within a limit of less than one-tenth of a wave-length of light

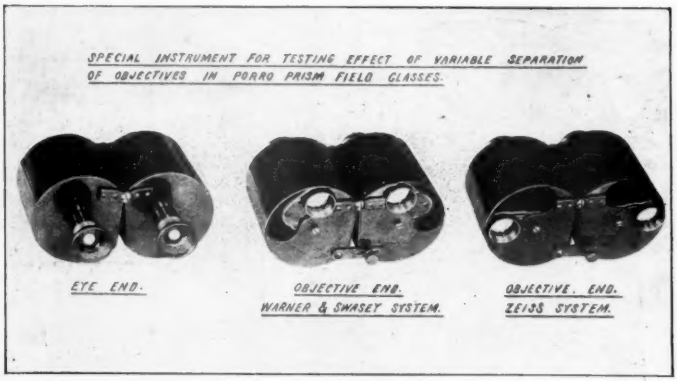

SPECIAL INSTRUMENT FOR TESTING EFFECT OF VARIABLE SEPARATION OF OBJECTIVES IN PORRO PRISM FIELD GLASSES.
EYE END.
OBJECTIVE END. WARNER & SWASEY SYSTEM.
OBJECTIVE END. ZEISS SYSTEM.

FIG. 10.

(meaning in linear measure, less than 1/500,000 of an inch), and it is a proper source of pride to us all that our honored fellow-member of this Society, Mr. John A. Brashear, is the founder and head of the works which lead the world in this class of production. The spectroscope prisms made in his laboratory are in use in the leading observatories of the world and have never been equalled, while the Porro prisms, which he manufactures by the thousands, are the most perfect ever made.

The credit for first applying the principle practically in bringing out a successful Porro prism field-glass belongs to Dr. Abbe of Jena, the able leader and manager of the famous Zeiss works, which have done so much in perfecting optical instruments. This was in 1895. Dr. Abbe's instrument, known as the "Zeiss," is shown in Fig. 9. This represents the original design which has remained unchanged since its introduction in the year mentioned.

The focal adjustment is made by separately turning each eye-piece on its axis. The American makers of this instrument, the Bausch & Lomb Optical Co., have recently improved it by adopting a universal focal adjustment. The two triple tubes are hinged so as to allow adjustment between the eye-pieces to suit the pupillary distance of the eyes of the observer. The hinge so connects the tubes as to place the objectives about an inch wider apart than the eyes, which feature has been alleged to impart a stereoscopic effect. As a matter of fact, the clearness and the sharpness of definition in these instruments were so far in advance of what had been previously obtained that the improvement was mistakenly attributed to the greater width between the objectives. This belief is still held by some persons who have not investigated the claim.

The facts are, however, easily demonstrated by means of an

FIG. 11.—GOERZ PRISM FIELD-GLASS.

instrument invented for the purpose and shown in Fig. 10. In the barrels of this instrument the triple telescope tubes are mounted to swing on the optical axes of the eye-pieces in such wise as to admit of being turned either to give the objectives the same relative position as shown in the Zeiss instrument, or to a position practically the same distance apart as the eyes. As the cut shows, the instrument is so constructed that tests can be made without the observer's knowing the positions of the objectives. Thereby all prejudice is eliminated, with the result that the keenest expert, observing an object across the street, or the distant landscape, cannot tell in which relative position the ob-

jectives are placed; which fact conclusively proves that, for field glasses the claim of increased stereoscopic effect by an increased separation of the objectives is untenable.

A short time after the introduction of the Zeiss glass came the Goerz binocular, illustrated in Fig. 11. This is also made in Germany. The pupillary distance is adjusted by parallel slides actuated by racks and pinions. A similar movement also gives universal focal adjustment. The present design of this instrument is the same as when first put on the market five or six years ago.

Fig. 12 shows the American model of universal prism field-glasses, brought out by The Warner & Swasey Company two

FIG. 12.—WARNER & SWASEY UNIVERSAL PRISM FIELD-GLASS.
The American Model.

years ago. The illustration is largely self-explanatory and shows how simple and symmetrical design may embody all essentials with a minimum number of parts. That this point is appreciated is proved by the fact that the design has been frankly copied by leading manufacturers in this country and in England.

As an evidence of the development of manufacturing in the United States, it may be added that the highest quality of Porro prism field-glasses are made here and sold at the same prices that are charged for similar instruments in London, Paris, and Berlin, the American interchangeable system of manufacturing counteracting the effect of European cheap labor.

So, then, for soldier and sailor, sportsman and scientist, tourist and—engineer, let us say—these admirable instruments are being turned out in ever increasing numbers, and there is no limit yet apparent to the demand; for, be it remembered, in our progressive country, the luxuries of today are the necessities of tomorrow.

DISCUSSION.

Mr. William Kent.—I would like to ask Mr. Warner to explain how it is that the rays which enter the prism get deflected at right angles, while the parallel rays the second time around go through and are not deflected.

Mr. Warner.—You are referring to Fig. 6? Please refer to Fig. 2; that will answer the question. The two Porro prisms are set so that the long axes of the prisms are at right angles with each other.

Mr. Emory.—I do not rise in criticism of the paper, but to ask for information upon one or two points. Mrs. Emory has been using the glass for observing birds—studying birds in their native haunts. In order to study the bird properly it must be studied through the glass. She soon concluded that either she was a very poor observer or the standard books on ornithology were wrong, because she could not get the tints to agree.

In studying nature the question is as to truthfulness of color. She observed that the finer tints of some of the birds, where the tint is delicate, is difficult of distinction, but the definition is very much finer than with the other glasses; you can see a bird much quicker; you can get it in focus quicker; and you can catch it on the wing—in fact, make very much finer observations of the form, flight, and other characteristics of the bird.

I suppose that the manufacturers have considered this matter very carefully and know to what extent this difficulty has been eliminated. I would like to know to what extent it can be further eliminated.

Mr. Warner.—I am very glad to say, just at this point, that Mr. Brashear has come into the room; he has made a scientific study of color—in fact, has delivered lectures on the subject and given all of these details—and if Mr. Brashear will answer Professor Emory's question it will be much more satisfactory to all, I am sure.

Mr. John A. Brashear.—The question is certainly a legitimate one. The selective absorption in a glass is a question which is very interesting to the optician. Some of the finest and most

valuable kinds of glass have recently been invented by the manufacturers of optical glass in Jena in Germany, the government having provided a subsidy of some 60,000 marks for experimental purposes.

The glass from which the prisms of this binocular is made is one of the new kinds made at Jena, and is called boro-silicate crown; as Mr. Warner has already pointed out, it is very superior for this purpose, having but a small selective absorption for the white light which passes through it.

This is not the case with a great many reflecting and refracting materials. Take, for instance, a highly polished silvered surface such as we find in the best mirrors. You would probably imagine that it reflects most of the light which falls upon it; but if you arrange two mirrors in such a way that a beam of white light containing all the colors of the spectrum, shall have twelve reflections, you will find the beam of light at the last reflection to be almost pure red, having been robbed of the violet, blue, and green waves. Many kinds of glass have the same properties. The dense Faraday glass will absorb nearly all the short waves after transmission through four or five inches of thickness.

The boro-silicate crown is very white and transparent. It is also what we call a *dry* glass. Many of the crown glasses made have a great affinity for the moisture in the atmosphere, perhaps on account of the potash in them, and are called hygroscopic. They soon become dimmed over the surface, thus shutting out, as well as diffusing, much light. The polished surface of the boro-silicate crown remains free from "patina" for years.

I wish to say that the larger share in the development of this excellent field glass is due to The Warner & Swasey Company. They have studied it in every part, eliminating all superfluous attachments; made every part interchangeable; and, what is most important, have given to the two systems (*i. e.*, the two tubes with their optical parts) a most perfect alignment with one another, without which, even if all other things were made perfect, the instrument would not fulfill the function of a high-grade field glass.

I have been requested so many times by our secretary and other members of the Society to give you a paper on the preparation and testing of accurate optical surfaces that I will bend every effort to prepare such a paper for one of our meetings in 1902.

Mr. James M. Dodge.—I would like to ask Mr. Brashear whether the tremulousness of the glass when held in the hand

does not account for a great deal of the difficulty. I know by personal experience in using marine glasses on a power yacht, that the vibration of the engine makes it very difficult to distinguish clearly the red and green lights of other vessels. There must be an impression made on the eye by the motion that is confusing. If the glass can be held with absolute steadiness, it is possible to distinguish objects which cannot be seen if the glass is shaking.

Mr. Brashear.—That is true in one sense of the word, and also in another, in that the powers being so high add to the tremulousness, because it must be remembered that every increase of power put upon an instrument magnifies all motions and imperfections in the same ratio, especially disturbances in the atmosphere.

*Mr. Warner**.—Just a word regarding the power, the question raised by Mr. Dodge. It is most natural, and I think, usual, for people purchasing a terrestrial telescope, especially of the binocular type, to feel that they want to get as high a power as possible.

I remember meeting a gentleman on the steamer who had a field glass magnifying twenty diameters which I think cost eighty dollars or about that. While he was observing a passing ship—and, as he had this fine glass which he had bought in Paris, many of his friends were around him, also watching the ship—I stepped up to him and asked the privilege of trying it, and incidentally I said, "Can you read the name of the ship?" He said, "No, I cannot;" I handed him an eight-power prism glass to use while I was using his, and he at once read the name with the low power glass; not because the low power would define it better if it was still, but because, with the high power, the motion of the steamer and the tremulous motion of his hands made it very difficult to define anything; while the lower power, having a lesser apparent motion, enabled him to at once read the name of the ship.

Mr. Brashear.—There is an axiom among astronomers which may be of value to you gentlemen who have to use telescopes occasionally. The axiom: always use the lowest power with which you can see best the object observed.

* Author's closure under the Rules.

THE VARIABLE STAR U CEPHEI.

IDA I. WATSON.

For Popular Astronomy.

U Cephei, a variable star of the Algol type, was discovered in 1880 by Ceraski at Moscow, and since that time has held the attention of many observers.

Since it is a circumpolar star it can be observed during the greater part of the year. Moreover it is of sufficient degree of brightness throughout its whole range of variation to be within reach of the small telescope. Thirdly, since its period is approximately two and a half days, it is possible to observe a minimum every five days. Alternate minima will of course occur in the day time. It requires five hours to obtain a complete minimum of the variable, and therefore a minimum which takes place between nine o'clock in the evening and three o'clock in the morning can be observed. Since the period is eleven minutes short of being two and a half days in length, two periods will bring the minimum twenty-one minutes earlier every five nights. If this phase occurs at three o'clock in the morning then after thirty-six periods, the minimum will take place at nine o'clock in the evening. Thus eighteen minima in succession can be observed, whereas in the case of Algol, in the same interval of time, three months, fifteeen minima are visible to the observer. The latter star, however, has one advantage over U Cephei. Since the duration of its least light is only twenty minutes, a complete observation of the minimum phase requires but two hours and a half.

A general characterization of the activity of U Cephei is as follows. Its range of variation is from 7.1 to 9.5 in magnitude and the rapidity with which it varies especially during the stage of decrease is remarkable, for it loses in light at this time more than a magnitude an hour. After remaining quiescent for more than an hour and a half, it rises to its normal magnitude at a rate somewhat more gradual than occurred in the stage of decrease. The color of the variable, which is ordinarily white, changes as the star declines, and becomes decidedly red or "ruddy at minimum" as the observations of Knott show. These observations, which are very complete, were published in 1899 in the *Memoirs of the Royal Astronomical Society*, Vol. LII.

Meridian observations of U Cephei were made as early as the year 1790 by Fedorenko, and in 1828 by Schwerd. The latter made several estimates of the star's magnitude which differed so

much in value that Chandler used one of the observations which seemed to indicate that the star was then near a minimum, for the determination of a new period of the star. After its variability had been announced in 1880 it was observed by Schmidt, Wilsing and Knott, whose observations are of especial value in determining the length of the variable's period.

From his own data Schmidt draws the following conclusions:

From 34 Epochs P = 2.492884 days
" 77 " P = 2.492720 "
" 111 " P = 2.4927703 " $= 2^d\ 11^h\ 49^m\ 33^s.35$

From eighteen minima observed by Wilsing we find a period of $2^d\ 11^h\ 49^m\ 43^s.5 \pm 0^s.97$, there being a difference of $10^s.15$ between his determination and that made by Schmidt.

Knott, in 1884, decided that the length of the period was 2.4928722 days or $2^d\ 11^h\ 49^m\ 42^s.96$. This value is in almost perfect agreement with the first value of Schmidt, but differs from the third result by $9^s.61$. Knott himself says that the mean period of Schmidt is too short, the error having then (1884) accumulated to more than an hour and a quarter.

Chandler in his paper on the "Light Variations of U Cephei," has combined the evidence derived from the observations of these three observers, basing upon their results his adopted period. He also uses the magnitude value as estimated by Schwerd in 1828. This value 10^m, showed that the star must have been near a minimum, a very important piece of evidence for the determination of any change in the period. He then combined the assumed minimum of Schwerd, with observations of Schmidt, Wilsing, Yendell and Chandler and those made at Harvard, omitting all those which did not include both branches of the curve. These covered a long period of time, there being in all ten thousand epochs. The observations of Knott had not been published at this time and were not available.

A comparison of the observed minima throughout the whole interval was then made and a certain progression in the times of minima caused Chandler to think that the period must be lengthening, and that this change was not at a uniform rate.

Another paper of Chandler's published in 1893 throws further light upon the character of the period of U Cephei. About this time a decrease in the length of the period set in and the change was found to be no longer progressive but periodic. A new set of elements was therefore deduced which were as follows:

$$1880\ \text{June}\ 23^d\ 9^h\ 28^m + 2^d\ 11^h\ 49^m\ 38^s.25E + 95^m \sin(0^o.08E + 283^\circ)$$

In 1897 a revision of these elements was published giving still more accurately the periodic term.

1880 June $23^d\ 9^h\ 39^m.6 + 2^d\ 11^h\ 49^m\ 37^s.85E + 130^m \sin (0°.06E + 300°)$

In 1884 Knott published observations in the *Astronomische Nachrichten* and there called attention to certain peculiarities which he had noticed in the light variations of U Cephei. He found that at minimum the lowest magnitude reached was not always the same but differed two or three tenths in value. Since this variation occurred with regularity and revealed itself alternately he concluded that there must be an actual difference in the star's behavior during this phase. He stated that the observable minima occurred in sets and in each set either a high or a lower magnitude was touched. The following table based upon Knott's observations published in the *Memoirs*, shows the peculiarities to which he wished to call attention. It should be noted also that the higher minima are characteristic of the autumn months and the lower of the spring months. Of the nineteen low minima all occur in the months from January to May the range of observation being from 9.4 to 9.5 in magnitude. There are eight high minima, and these with but one exception take place in the months from October to December. Here the light value is from magnitude 9.2 to 9.25. In the minimum of Jannary 6, 1881, we have a high magnitude, 9.1, occurring in a spring month. The observations seem to support Knott's theory.

EVEN MINIMA.

Date of Minima.	Gr. M. T.		Magnitude.	E.
	h	m	m	
1881, March 29	12	45	9.4	112
1881, April 3	12	24	9.4	114
1881, April 28	10	38	9.4	124
1881, May 3	10	23	9.4	126
1881, May 8	10	1	9.4	128
1882, March 18	12	21	9.5	254
1882, April 7	11	5	9.45	262
1882, April 22	10	5	9.5	268
1882, April 27	9	45	9.45	270
1883, March 2	12	36	9.45	394
1883, March 12	11	49	9.4	398
1883, March 22	11	10	9.45	402
1883, April 1	10	29	9.45	406
1884, February 29	11	36	9.4	540
1884, March 20	10	16	9.45	548
1885, March 14	9	32	9.45	692
1885, March 19	9	12	9.45	694
1887, January 26	10	45	9.4	966
1887, February 25	8	34.5	9.4	978

ODD MINIMA.

Date of Minima.	Gr. M. T.		Magnitude.	E.
	h	m	m	
1880, December 2	9	0	9.2	65
1881, January 6	6	36	9.1	79
1881, October 2	11	47	9.2	187
1881, October 17	10	44	9.2	193
1881, December 21	6	24	9.25	219
1882, October 31	8	40	9.2	345
1882, November20			9.2	353
1883, October 20	8	34	9.2	487

In the paper on the "Light Variations of U Cephei" previously referred to, Chandler considered Knott's theory and his reasons for advancing it. The variation in magnitude at minimum is not due, he thinks, to any real change in the star, but to a subjective effect of a change in the position of the variable and companion star, relative to the eyes. As the two stars change their parallactic angle their positions relative to the line connecting the two eyes will change very considerably. This is known to give rise to different estimates of relative brightness. When on the meridian two stars of the same declination will be parallel to the line connecting the eyes, the position considered most favorable for correct comparison.

Since Knott was an experienced observer he probably knew of this subjective error and made allowance for it. Further the following conditions are worthy of attention.

During the immediate stage of minimum Knott compares the variable almost exclusively with the star B.D. + 81°.22. It happens that this star differs in declination from the variable by only 2′, so that for the reason just given any comparison of U Cephei with this star will be free from the subjective error when the stars are on or near the meridian. Eighteen minima observed by Knott from December 1880 through April 1, 1883, occurred within a short time of either upper or lower transit, the even minima at lower, the odd at the upper meridian.

This point could be definitely settled if two observers about twelve hours in longitude apart watched the variable during successive epochs. For example, if one minimum were observed in San Francisco, the next succeeding which to the same person would be invisible, could be seen by an observer in Moscow. Thus we should have observations of successive minima which might prove whether the magnitude at the minimum phase really varies.

The diminution of the light of U Cephei at minimum is held to be due to the eclipsing of the star by a companion. This body moves in an orbit supposedly circular, with a radius twice as

large as that of the bright star. The two components are separated from contact by only a fifth of a radius of the orbit. Thus they form a very close system.

The deduction of the relative size aud brightness of the comparison stars of an eclipsing system is so simple that I will give the steps here:

Let A and B represent the two stars, A being considered the primary. The eclipse is regarded as central.

Let S = surface of star A regarded as a disc *i. e.*, πR^2
Then Sx = surface of star B = πr^2
And 1 = brightness of star A per unit surface.
y = brightness of star B per unit surface.
Then S = total brightness of A
And Sxy = total brightness of B
$S + Sxy$ = brightness for maximum
$S - Sx + Sxy$ = brightness for lower minimum
S = brightness for higher minimum

Let $$n = \frac{\text{brightness of maximum}}{\text{brightness of lower minimum}}$$

And $$n' = \frac{\text{brightness of maximum}}{\text{brightness of higher maximum}}$$

Then $$\frac{S + Sxy}{S - Sx + Sxy} = n$$

And $$\frac{S + Sxy}{S} = n'$$

These equations are general applying to any two companions whatever the relative size or brightness. With Algol stars the higher minimum does not occur. The maximum brightness continues from inferior conjunction to inferior conjunction, that is n' is equal to one.

In the case of U Cephei n is equal to five.

Hence $$\frac{S + Sxy}{S - Sx + Sxy} = 5$$

And $$\frac{S + Sxy}{S} = 1$$

$$1 + xy = 1$$

$$xy = 0$$

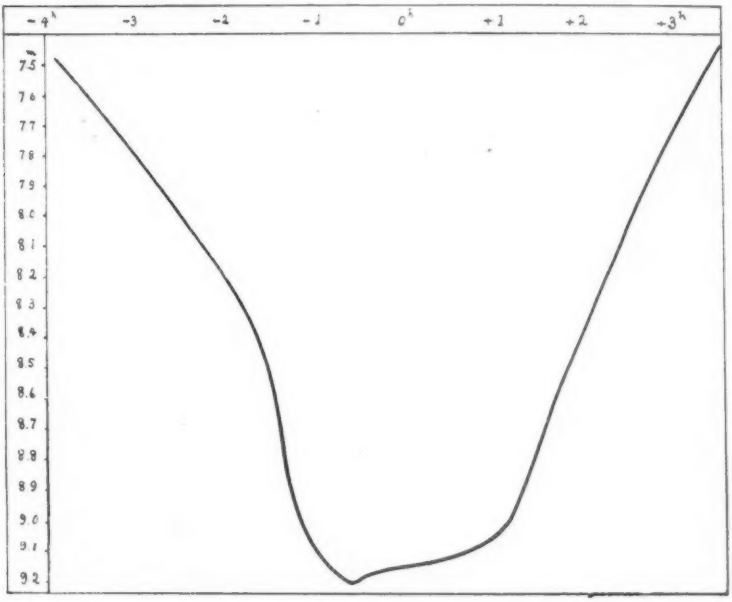
$$\frac{1}{1 - x} = 5$$

$$x = \frac{4}{5};\ y = 0$$

Therefore the smaller body is dark and presents four-fifths the surface of the brighter star, and the radii of the two bodies are in the ratio $\frac{2}{\sqrt{5}}$.

The variation of the period as demonstrated by Chandler is explained by him as follows: The two bodies A and B revolve around a third dark body in a period of about 30.7 years and at a distance about equal to the radius of Saturn's orbit.

Light curves from the observations of Knott and Chandler have been plotted by the writer to show the nature of the light



variations. Knott's curve makes the minimum phase flat and unvarying throughout. Other observers agree that this is not the case. There is a decided fluctuation in the brightness at minimum very similar to that shown in the light changes of S Cancri at the same phase. The accompanying curve has been plotted from the autumn mean-light curve given by Chandler. It shows that there is a gradual increase in the star's brightness after it has once touched its lowest point. The spring observations showed this in a less marked degree, the curve being more nearly flat and more symmetrical in form than the autumn curve.

VASSAR COLLEGE OBSERVATORY, April, 1902.

A DEVICE FOR CONDUCTING ELECTRIC CIRCUITS TO THE EYE END OF AN EQUATORIAL TELESCOPE.

W. WALTER DINWIDDIE.

For Popular Astronomy.

An ideal device for conducting electric circuits from the pier to the eye end of an equatorial telescope should be absolutely certain of continuous contact, so that it may be used for the chronograph signals. When once established it should require no attention, and should never get out of order.

This theoretically simple problem has had several more or less unsatisfactory solutions. Flexible cables are used on most of the large modern telescopes, but it is well known that this arrangement is far from perfect. For example in reversing the telescope the observer has to be continually on the outlook for the cables. The instrument can never turn through a whole revolution on either axis, and often valuable time is consumed in turning it the long way round so as not to break the cables.

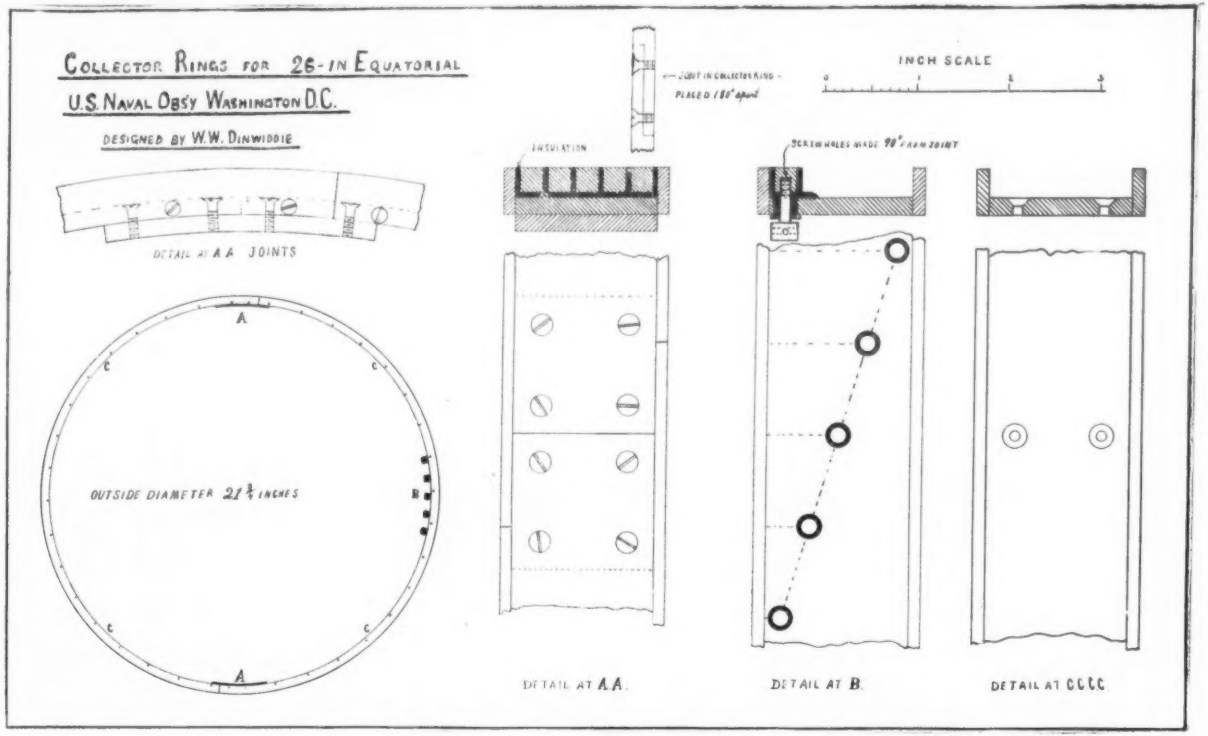
Contact rings have been used in some cases, but with unsatisfactory results, at least as far as I have been able to find out. The difficulty lies wholly in the fact that little care has been taken in their design, as regards either mechanical or electrical details.

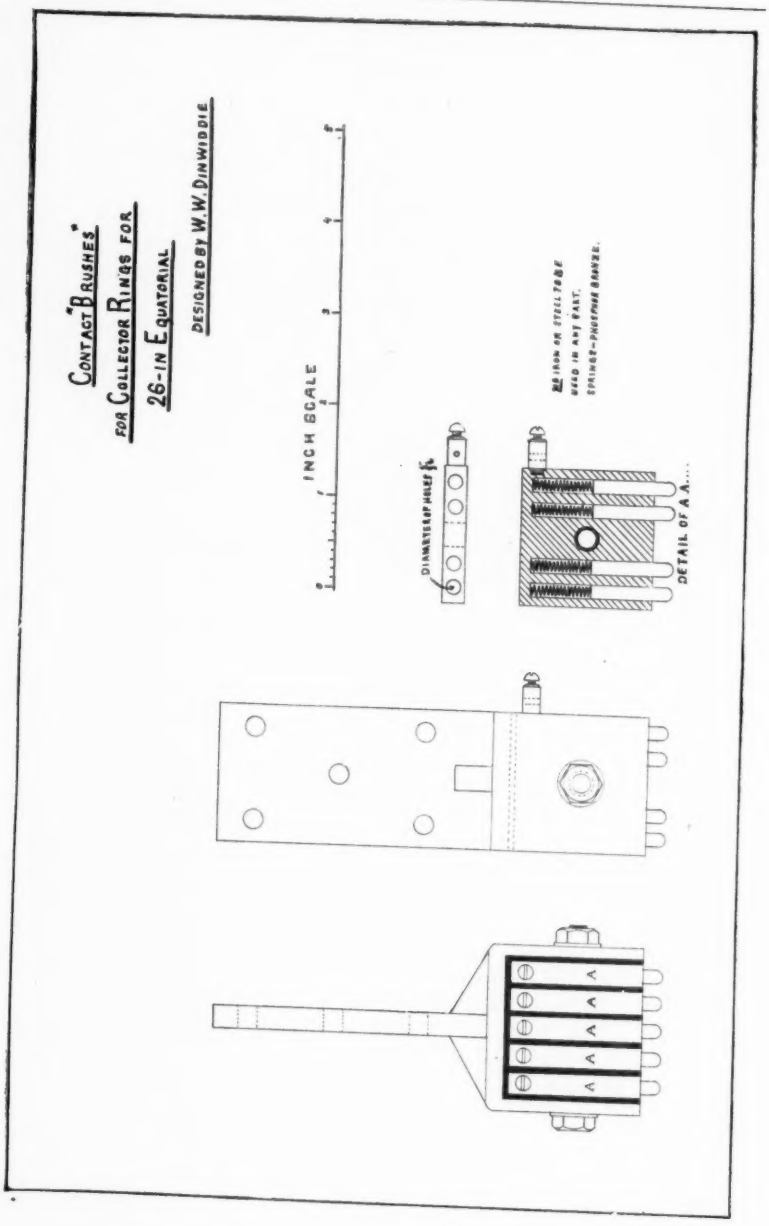
The system recently put in use on the 26-inch equatorial telescope at the U. S. Naval Observatory is so thoroughly satisfactory in every way that it seems worth while to describe it.

Professor Ormond Stone has since applied this arrangement to the 26-inch Leander McCormick telescope at the University of Virginia, where it has given excellent results.

As designed for the 26-inch equatorial at Washington each ring has five conductors, making it possible to have four independent circuits. The ring about the polar axis is attached to the right ascension clamp ring, and turns with the axis, while its brush is fastened to the case of the worm screw. The other ring is fastened to the declination sleeve, and its brush to the declination clamp ring.

The base of each ring is made in two pieces so that it may be put on without dismounting the telescope. A sheet of fibre insulation covers this base ring. The conductors of one-fourth-inch square brass rod are screwed together and the joints soldered. They are then slipped on over the fibre, and the side of the base ring is screwed on.


COLLECTOR RINGS FOR 26-IN EQUATORIAL
U.S. NAVAL OBSY WASHINGTON D.C.
DESIGNED BY W.W. DINWIDDIE
DETAIL AT A A JOINTS
A
C
C
OUTSIDE DIAMETER 21 3/4 INCHES
B
C
C
A
JOINT IN COLLECTOR RING
PLACED 180° apart
INCH SCALE
0
1
2
3
INSULATION
SCREW HOLES MADE 90° FROM JOINT
DETAIL AT A.A.
DETAIL AT B.
DETAIL AT C.C.C.C.


CONTACT BRUSHES
FOR COLLECTOR RINGS FOR
26-IN EQUATORIAL
DESIGNED BY W. W. DINWIDDIE
INCH SCALE
DIAMETER OF HOLES
DETAIL OF A A

The insulation between the conductors is cord saturated with P. B. paint and wound on before it dries. It is wound from six bobbins one turn at a time in each space, in order to get the spaces of uniform and equal width.

The conductors and the main part of the base ring may be bent in the rolls ordinarily employed by tinners for straightening tin. The easiest way to make the sides of the main ring is perhaps to have them cast in sections and then spliced.

The brushes have five conductors separately insulated to correspond to the number of conductors on the rings. Each conductor of the brush has four contact pins, and each pin is pressed against the ring by a separate spring, thus making it impossible for a particle of dust on the ring to interrupt the circuit. This part of the device is a marked improvement on the flat springs heretofore used.

The cost of two rings and two brushes for this instrument was $70.00. In addition to this it took two men about three days to put them on the telescope when delivered at the Observatory.

U. S. Naval Observatory, Washington, D. C.
April 28th, 1902.

ON THE COMPUTATION OF TRANSIT-FACTOR TABLES FOR ANY GIVEN LATITUDE.

HERMAN S. DAVIS.

Astronomers using Mayer's form* of reduction of transit observations will find tables of the coefficients A, B, C, in one of the Reports of the Superintendent of the U. S. Coast and Geodetic Survey† and in similar publications. These tables are intended for use with portable transit instruments and have the double argument ϕ and δ. But both amateur and professional astronomers in their fixed observatories find it more convenient to have special tables for their own latitude so that δ will be the only argument of entry. Not infrequently, however, they are deterred from computing such tables by reason of the labor involved—slight as that labor ought to be considered even by the method usually adopted.

Doubtless many of the readers of Popular Astronomy have transit instruments with which they are accustomed to making

* Chauvenet's *Practical Astronomy*, Vol. II, page 145.

† Report for 1897-98, Appendix No. 7.

time observations and yet who may be placed in the list of persons who dread the long labor of constructing such tables for personal use. For the benefit of these, I wish to point out a very simple form in which to put the calculations so that the total time consumed in the formation of the table will not exceed eight hours—and may be considerably less according to the skill of the individual in numerical reckoning.

The usual method of computing these coefficients is by the aid of logarithms and the conversion of the resulting values of log A, log B, and log C, into the natural numbers A, B, C, tabulating them for particular values of the declination close enough to permit of ready interpolation. The actual form of computation is, therefore,

$$\log A = \log.\sin(\phi - \delta) + \log.\sec \delta.$$
$$\log B = \log.\cos(\phi - \delta) + \log.\sec \delta.$$
$$\log C = \log.\sec \delta.$$

and A, B, C, are usually tabulated to three decimal places.

It is the claim of this paper, however, that the natural values of A, B, C, may be much more readily tabulated by the natural trigonometrical functions and Crelle‡ without the use of logarithms at all: for the above formulæ may be written:

$$A = \cos\phi\,(\tan\phi - \tan\delta).$$
$$B = \sin\phi\,(\cot\phi + \tan\delta).$$
$$C = \sec\delta.$$

For the practical calculation of these it is only necessary that the paper be ruled with seven columns. In the first column insert every argument of δ for which you intend to construct the table,—say for every 20′ from $-25°$ to $+25°$, for every 10′ from $+25°$ to $+50°$, for every 5′ from $+50°$ to $+66°$. From $+66°$ to $+80°$ they should be for every 2′ of both δ and $(180° - \delta)$. Above 80° computations need be made for every 30″ but only for several minutes of arc (= ten times the annual precession in δ) on each side of the mean position of each of the Ephemeris-polar-stars for the epoch 1910, both above and below the pole.

When the paper has been thus ruled and the δ written in the first column of each page through all the sheets, insert the natural tan δ from the tables¶ into the second column and at the same time insert also natural sec δ in the seventh column. Continue this through all the pages.

Next compute column 3 by writing the value of tan ϕ to three

‡ Crelle's *Rechentafeln*, or Bremiker's edition of Crelle's *Calculating Tables*. Berlin 1898.

¶ Albrecht's *Logarithmisch-Trigonometrische Tafeln*, pages 152-6.

decimals on a strip of paper and subtracting from it each tan δ in turn. In like manner compute column 4 by adding cot ϕ to each tan δ in turn. Column 5 is computed by aid of Crelle, using cos ϕ as a constant factor for the multiplication of each quantity in column 3. In like manner compute column 6 using sin ϕ as a constant multiplier of each quantity in column 4. This being completed, you will have,

A as the quantity in column 5
B as the quantity in column 6
and C as the quantity in column 7

That this procedure is much shorter than the "old" method is shown by the following comparison:

	Old	New
Number of figures	49	30
Number of angles	2	1
Quantities from printed tables	6	4
Additions and subtractions	3	2
Multiplications (without logarithms)	0	2

In the last point, where the new is at the disadvantage of the old method, the labor diminishes as the number of arguments increases since the factor used in Crelle is constant for all arguments of δ. Also this disadvantage is far more than off-set by the fact that every trigonometric function is taken out of the tables without interpolation for the odd minutes and seconds involved in the angle $(\phi - \delta)$ used in the old method. It will be noticed, too, that the additions and subtractions under the new method are for a fewer number of figures for each quantity than for the logarithms of the old method requisite to secure the same accuracy in the third decimal of the resulting A, B, and C.

Another advantage of this method is that there are no intermediate steps in the computation to be afterwards discarded—preserve them all in these seven columns and you have ready at hand not only the coefficients used in the form suggested by Mayer, but for Bessel's‖ and for Hansen's‖ form as well, viz.:

Bessel's ..... $m + n \tan \delta + c \sec \delta$

of which tan δ is in column 1 and sec δ in column 7.

Hansen's ..... $b \sec \phi + n (\tan \delta - \tan \phi) + c \sec \delta$

of which sec ϕ is a constant, $(\tan \delta - \tan \phi)$ is in column 3 with reversed sign, and sec δ in column 7.

There are several ways of verifying the accuracy of the resulting A, B, and C. Perhaps the first one which would be thought of is

‖ Chauvenet's *Practical Astronomy*, Vol. II, page 144.

(*a*) Do the additions and subtractions in blocks of ten and verify the multiplications by seeing that the sums of the blocks of ten in columns 5 and 6 are equal to the products of the sums of the same blocks in the corresponding columns 3 and 4, according to the principle:

$$ax + ay + az + \ldots\ldots = a\,(x + y + z + \ldots\ldots)$$

Another method is:

(*b*) To test each value of A, B, and C separately by the criterion

$$A^2 + B^2 = C^2$$

using Barlow's tables§.

All the A, B, and C, for values of $+\,\delta$ for which there are corresponding values of $-\,\delta$ may be checked by

(*c*) Using the criteria

$$\begin{aligned} A + A' &= 2A \text{ (for } \delta = 0^\circ) = 2 \sin \phi \\ B + P' &= 2B \text{ (for } \delta = 0^\circ) = 2 \cos \phi \\ C & \quad C' \end{aligned}$$

where the primed letters correspond to the negative δ, and in which it is presumed that the letters with the primes and without have been computed entirely independently of each other originally.

The two quantities A and B may also be checked by

(*d*) The method of differences, according to the fact that

$$\begin{aligned} dB &= -\tan \phi \,.\, dA \quad \text{when } \phi < 45^\circ \\ \text{or} \quad dA &= -\cot \phi \,.\, dB \quad \text{when } \phi > 45^\circ \end{aligned}$$

But probably the most satisfactory method of all is:

(*e*) To prepare two sets of sheets ruled with the seven columns. In the first set insert only every alternating value of the argument δ for which the computation is to be made, writing the same on alternating lines of the paper. Make the computation throughout for these arguments only. Then fill in the blank lines in columns 5, 6 and 7, only, by direct interpolation between the values computed in full. Then prepare the second set of sheets in the same way but with only the arguments of δ which had been omitted in the first set. Carry the computations through and interpolate in like manner as before. If this should be done completely independent of the first set, it is equivalent to a duplicate computation and both sets should agree within a unit in the third decimal place, yet without increasing the time and labor by more than one or two per cent instead of doubling it.

§ Barlow's *Tables of Squares, Cubes, Square Roots, Cube Roots, Reciprocals* of all integer numbers up to 10,000.

For Observatories or amateurs located within a few degrees of each other in latitude, it is obvious that tables constructed for the one location can be converted into tables good for the other place by aid of a tiny table of limiting-values of m good for either the argument A or B indiscriminately but to be applied as follows:

denote $d\phi$. B as $= m_B$ and $d\phi$. A as $= m_A$

then at the second location as derived from the first we have

$$A_2 = A_1 - m_B \qquad B_2 = B_1 + m_A \qquad C_2 = C_1$$

where the subscript A or B denotes the argument of entry to the table, to secure the proper value of m.

In accordance with the above principles Miss Dow has recently computed for me a complete set of tables for the latitude of 38° 6′ 44″.1 in less than the time specified above; and in like manner Professor Wright of Lincoln University, Penn., has computed a set for the latitude of his Observatory,—the two tables being doubly verified by application of the last paragraph above.

International Latitude Observatory,
Gaithersburg, Maryland.

THE MOTION OF THE SUN AND STARS IN SPACE.

W. H. S. Monck.

For Popular Astronomy.

Our computations of the Sun's motion in space usually proceed on the supposition that the stars—at least if we take a sufficient number of them—are moving indifferently in all directions. But is this assumption correct? That the great majority of stars belong to the Galaxy or Galactic System seems highly probable. But the Galaxy presents the appearance of a ring, though no doubt an irregular ring. Does this ring revolve carrying the greater part of the stars with it? That has been suggested before. According to the late Mr. Jacob Ennis one of the greatest unsolved problems of astronomy was, in which direction does the Galaxy revolve? I admit that it may not revolve at all, but the question whether the proper motions of the stars do or do not indicate such a revolution is at all events well worthy of examination.

I have lately been examining M. Bossert's "Catalogue of Stars with large Proper Motion," in the *Annals of the Paris Observatory*, published in 1896. It is I think the largest catalogue of the kind which I have met with—the number of stars being be-

tween 2600 and 2700. This number ought to be sufficient to exclude chance and introduce us to the element of law. I first examined the movements to or from the North Pole. The Sun is known to be approaching the North Pole and this motion makes the stars generally appear to recede from it. And a count of the stars will enable us to make a fair estimate of the Sun's velocity in this direction compared with their average velocity. One-half the stars are, according to our original assumption, approaching the North Pole and the other half receding from it. Suppose that the Sun was moving with average velocity, it would cause an apparent reversal of the motion of one-half of the approaching stars and we should have three-fourths of the stars (apparently) receding and one-fourth approaching. This is very nearly what I actually find. Of 2641 stars in the Catalogue 1865 are receding from the North Pole 579 approaching and 197 have no motion in declination. The Supplement gives 29 approaching to 4 receding. The Sun's motion is about the average; and if the stars are moving indifferently in all directions, the average motion towards or away from the North Pole is probably about the same as the average motion towards or away from the Earth as revealed by the spectroscope. Our rate of approach to the North Pole may therefore be set down as 10 miles per second or a little more.

But let us turn to the Galaxy. It makes its nearest approach to the North Pole in Cepheus at about 12^h right ascension and it reaches its southern limit at not far from the same degree of right ascension. Supposing therefore that it revolves, carrying a great part of the stars with it, we may expect that the stars whose right ascension is 0^h to 12^h will exhibit an opposite tendency as regards the North Pole from those whose right ascension is from 12^h to 24^h. I accordingly tried the two intervals separately with the following result,

	Approaching.	Receding.	No. Motion.
First twelve hours.....R. A.	244	966	105
Second twelve hours.....R. A.	335	899	92

While other explanations of these figures are no doubt possible, they suggest a revolution of the Galactic Ring such that the stars in the second twelve hours of right ascension are moving towards the most northern point of the Galaxy in Cepheus while those in the first twelve hours are moving away from it.

I now pass to the motions of the stars in M. Bossert's Catalogue in right ascension. Supposing that the Sun is moving towards a point whose right ascension is 18^h (or 270°), the

effect will be to make all the stars apparently recede from that point. But in thus receding, those whose right ascension is between 6^h and 18^h (passing through 12^h) will diminish their right ascension, while those between 18^h and 24^h as well as those between 0^h and 6^h will increase it. If we can divide the hours of right ascension into two equal parts one of which exhibits the maximum amount of motions in increasing right ascension, and the other the maximum amount of motions in diminishing right ascension we have obtained the right ascension of the Sun's goal. And there will be two neutral points where we pass from increasing to diminishing right ascensions an *vice versa*, which ought to differ from each other by 12^h or 180^h. Such would be the result if the stars were moving indifferently in all directions. But what would be the result if there was such a revolution of the Galaxy as I have suggested? The Sun's motion towards a point in R. A. 18^h would make the stars whose R. A. was 19^h or 20^h apparently recede from that point but the revolution of the Galaxy would carry them towards it and owing to the conflict of opposing motions the neutral point would be displaced in the direction of 24^h. An opposite result would take place near the other neutral point which I have supposed to be at 6^h. It would be displaced in the direction of 1^h; and instead of 12^h with increasing right ascensions, and 12^h with diminishing right ascensions, we would find (owing to this displacement) perhaps 11^h of increasing right ascensions and 13^h of diminishing right ascensions, the neutral points thus not being diametrically opposite. (The figures which I have used in this instance are only for illustration).

Now this is exactly what I find. The first neutral point is pretty sharply defined at about $6^h\ 22^m$, but it is not till about $19^h\ 45^m$ that movements in increasing right ascension attain any decided preponderance. During more than 13 hours of right ascension movements in diminishing right ascension preponderate while movements in increasing right ascension preponderate during less than 11 hours. And not only does this preponderance of diminishing right ascensions take place over a larger region of the sky but this region contains a greater number of stars, viz, about 1450 agains 1190. Of the stars in the Catalogue, however, the number with diminishing right ascensions is only 1206 against 1144 with increasing right ascensions the remainder being neutral—not a very marked difference though favorable to the hypothesis of Galactic revolution as far as it goes. I may add that so far as this Catalogue is concerned, the effect of the

Sun's motion is less strongly marked in right ascension than in declination—indicating, I apprehend, that the declination of the Sun's goal is over 45° N. I make the numbers in the part of the sky where increasing right ascensions prevail 760 to 330 with 101 neutral while in the part where diminishing right ascension prevail they are 876 to 384 with 190 neutral. The preponderance in both instances falls considerably short of the 3 to 1 which proportion is practically attained as regards proper motions in declination.

There are some other features in the proper motions of the stars in this Catalogue which seem to me to indicate a connection with the Galaxy. The two neutral points are situated near where the Galactic Circle cuts the equator. But the first of these points is situated at a narrow part of the Galaxy and the second at a wide one in which the Galaxy is divided into two streams or branches. Now the first neutral point is sharply defined at about $6^h\ 22^m$. We pass from increasing to diminishing right ascensions almost at once. But the second neutral point is very ill defined. Thus in the page of the Catalogue which begins at $17^h\ 36^m$ and ends at $18^h\ 13^m$, there are 18 increasing right ascensions, 17 diminishing and 15 neutral. It would seem that we had reached and passed the neutral point; but on the next page which ends at $18^h\ 50^m$, the preponderance of diminishing right ascensions is re-established, the numbers being 30 to 13 with 7 neutral; On the next page the majority sinks to 25 to 21 with 4 neutral and then for the interval $19^h\ 26^m$ to $19^h\ 56^m$ we obtain almost the same result as for the interval $17^h\ 36^m$ to $18^h\ 13^m$; viz: 20 increasing right ascensions, 19 diminishing and 11 neutrals; and down to $20^h\ 25^m$ the preponderance of increasing right ascensions is still in doubt.

In dealing with this Catalogue it should be borne in mind that about two-thirds of the stars comprised in it are situated in the northern hemisphere. This is probably not owing to the greater proper motion of the stars in that hemisphere but rather to the more careful study of these stars which has enabled a larger number of considerable proper motions to be detected. But it probably has the effect of giving to the motions of the stars, when averaged, what I may call a northern aspect; and it would be interesting to test the results which I have suggested by an examination of the proper motions of northern and southern stars, taken separately. The object of the present paper is rather to suggest investigation than to lay down scientific results. But I think it clear that after we have employed a sufficient number

of stars to eliminate chance—over 2600 in the present instance—we meet with results which are inexplicable by the solar motion and indicate a prevalent star-drift in certain regions of the sky. And in making a correct estimate of the direction and velocity of the Sun's motion in space this star-drift ought not to be neglected. The direction of the Sun's motion according to this Catalogue is I think, about 285° + 50° but I have not made any attempt to work out the problem mathematically. The real neutral points are, I think, situated at about 7^h and 19^h of right ascension, the displacement being due to star-drift. The study of this star-drift deserves more attention from astronomers than it has yet received.

It may perhaps be thought that I have assumed that the Sun does not participate in what I regard as the general movement of the stars. Bnt I merely assume that since the period at which the Sun's motion in space was first investigated, this motion has not perceptibly varied from a right line. That the point towards which we are moving—the Sun's goal as it may be most briefly designated—will not remain fixed, I have little doubt, and very possibly in another century our descendants may be able to trace the change which I expect will be a diminished right ascension and increased northern declination. If indeed we could rely on the accuracy of small proper motions we might do something in this way already. Taking stars whose proper motions were so small as to suggest that their distances were on the average greater than those in M. Bossert's Catalogue by 25 light-years, we might compare two determinations of the Sun's motion in space at an interval of quarter of a century.

It is not easy to decide how the numerous stars in this Catalogue which have no perceptible proper motion (whether in right ascension or in declination) should be treated. In some instances no doubt, we should look on them as stars whose genuine proper motion had been just balanced by that of the Sun; but when a star whose right ascension does not differ much from that of one of the neutral points has no perceptible movement in right ascension this result can hardly be ascribed to the Sun's motion overpowering that of the star. No doubt, moreover, all these stars have a proper motion both in right ascension and in declination. It is merely too small to be measured with certainty. Are we to assume that if the real movements were known one-half would be + and the other half — ? Or should we rather assume that the proportion of pluses or minuses among the stars whose motions are too small for measurement is the same as

among the neighboring stars whose motions are measureable? Or finally should we leave them out of account altogether and deal only with the stars whose proper motions both in right ascension and declination can be ascertained and measured? A similar problem occurs in the case of comets. The vast majority if not all, of those described as parabolic are no doubt either elliptic or hyperbolic. An exact parabola would hardly ever occur, and if it did so the attraction of the planets would suffice to upset it. But how are we to deal with these neutral or parabolic comets when we are attempting to ascertain the relative numbers of elliptic and hyperbolic comets? It is easier to propound such questions than to solve them; but was it not Bacon who said, "*Prudens interrogatio est dimidium Scientioe*?"

LIST OF VARIABLE STARS WITH DIFFERENT NOTATION.

H. C. WILSON.

At the suggestion of Mr. A. Stanley Williams we have prepared a list, as complete as possible from the data at hand, of the variable stars which have been assigned different names by those who have published lists of these stars.

The notation generally adopted by astronomers is that of Argelander, who designated the variable stars in each constellation by the last letters of the alphabet, in capitals, beginning with R. Nine variables can thus be designated in each constellation, and if the letters are assigned strictly in the order of discovery there can be no confusion. Of late years the number of known variables has increased to such an extent as to require many more than the last nine letters of the alphabet. Dr. S. C. Chandler in his catalogues of variable stars adopted the plan, suggested by Hartwig and approved by Schönfeld, Argelander's successor, of using two letters, RR, RS, RT, etc., thus providing for nine more variables in each constellation. In some constellations there have already been discovered more than eighteen variables, and the Variable Star Committee of the *Astronomische Gesellschaft*, in a recently published list (*A. N.* 3752) of variables which have been discovered since the publication of Chandler's "Third Catalogue" have extended the notation by using SS, ST, etc., TT, TU, etc. This method will provide for the designation of 54 stars. In the constellation Cygnus the number is already 34 (UU), and it seems likely that it will soon be necessary to use three letters as RRR, RRS, etc., if the method of notation by letters is to be continued.

Another and, it seems to the writer, a less cumbersome method of notation is used in the *Annuaire du Bureau des Longitudes*, from which the variable star data in the "Companion to The Observatory" are obtained. In this method the second nine variables in each constellation are designated by the single letters with the superscript numeral 2, as R^2, S^2, etc., the third nine by R^3, S^3, etc. This method is capable of indefinite extension without becoming cumbersome, but unfortunately it does not have the advantage of priority nor of adoption by those who are doing the most valuable variable star work. Its use has therefore led to considerable confusion.

If the letters were assigned strictly in the order of the discovery of the variables or if they were assigned in the order of right ascension at regular stated intervals of time, the complete lists of new variables being in hand, there would be the following equivalents, the first nine being the same in both systems of notation:

10	$R^2 = RR$	19	$R^3 = SS$	28	$R^4 = TU$	37	$R^5 = UX$
11	$S^2 = RS$	20	$S^3 = ST$	29	$S^4 = TV$	38	$S^5 = UY$
12	$T^2 = RT$	21	$T^3 = SU$	30	$T^4 = TW$	39	$T^5 = UZ$
13	$U^2 = RU$	22	$U^3 = SV$	31	$U^4 = TX$	40	$U^5 = VV$
14	$V^2 = RV$	23	$V^3 = SW$	32	$V^4 = TY$	41	$V^5 = VW$
15	$W^2 = RW$	24	$W^3 = SX$	32	$W^4 = TZ$	42	$W^5 = VX$
16	$X^2 = RX$	25	$X^3 = SY$	34	$X^4 = UU$	43	$X^5 = VY$
17	$Y^2 = RY$	26	$Y^3 = SZ$	35	$Y^4 = UV$	44	$Y^5 = VZ$
18	$Z^2 = RZ$	27	$Z^3 = TT$	36	$Z^4 = UW$	45	$Z^5 = WW$
							etc.

In the main these equivalents hold true in the accompanying list of variables with discrepant notation, but there are a few exceptions.

In the list the first column gives the number according to Chandler, which is obtained by reducing the right ascension for 1900 to seconds of time and dividing by ten. In a few cases the number thus obtained comes out the same for two or more stars, and the letters *a*, *b*, etc., are affixed in order to distinguish them. The second column gives the designation of the variable according to Chandler and the Variable Star Committee. The third column gives the designation according to the *Annuaire du Bureau des Longitudes* for 1902. The name of the constellation is omitted, for the sake of brevity, it being the same as given in the preceding column, except in three instances which are noted in the footnotes. The fourth column gives the number of the star in the *Companion to The Observatory* for 1902. The notation in the *Companion* agrees with that in the *Annuaire* with a few exceptions which are noted in the footnotes. The data given in the last four columns have been taken from Chandler's *Third Catalogue* and *Astronomische Nachrichten* No. 3752.

Number according to Chandler.	Chandler's Third Catalogue and Astr. Nach. 3752.	"Annuaire."	"Companion" No.	R. A. 1900.			Decl. 1900.		Magnitude.	
									Max.	Min.
				h	m	s	°	′		
980	V Persei	W	33	2	43	15	+ 56	34	7-8	9-10
2781	RR Puppis	S^2	90	7	43	32	— 41	07	9-10	10-11
2935	RS Puppis	R^2	94	8	09	14	— 34	17	7	8
3128	R Pyxidis	R*	103	8	41	17	— 27	50	8	< 11
3244	S Pyxidis	S†	107	9	00	41	— 24	41	8-9	< 11
3355	W Carinæ	V‡	109	9	19	15	— 55	32	7-8	8-9
3482	RR Hydræ	R^2	116¶ 117	9	40	24	— 23	34	8-9	< 12
3519	Y Hydræ	...	...	9	46	27	— 22	33	8	10
3569	RR Carinæ	R^2	...	9	54	50	— 58	23	8	9-10
...	... Velorum	R	...	10	02	24	— 51	42	6-7	7-8
3879	RS Hydræ	S^2	126	10	46	33	— 28	06	8-9	< 11
3983	RS Carinæ	S^2	...	11	03	54	— 61	24	8	11
4057	RS Centauri	S^2	131	11	16	06	— 61	20	9	< 12
4573	RU Virginis	U^2	147	12	42	13	+ 4	42	8	12
4665	RT Virginis	T^2	...	12	57	33	+ 5	43	8-9	10
4935	RT Centauri	T^2	155	13	42	30	— 36	22	8	< 12
5037	RR Virginis	R^2	158	13	59	35	— 8	43	11-12	< 14
5075	RU Hydræ	T^2	160‖	14	05	48	— 28	25	8	12
5099	RR Centauri	R^2	162	14	09	55	— 57	23	7-8	8
5174	RS Virginis	S^2	165	14	22	16	+ 5	08	8	12?
5405	RT Librae	T^2	174	15	00	47	— 18	21	8-9	11-12
5511	RS Librae	S^2	182	15	18	29	— 22	33	8	13
5566	RU Librae	U^2	183	15	27	41	— 14	59	8-9	< 12
5704	RR Librae	R^2	195	15	50	39	— 18	01	8-9	14
5752	RZ Scorpii	Z^2	198	15	58	37	— 23	50	8-9	< 10
5768	RR Herculis	R^2	...	16	01	28	+ 50	46	7-8	9-10
5796	RX Scorpii	X^2	...	16	05	56	— 24	38	9	< 12
5796*a*	RU Herculis	U^2	204	16	06	03	+ 25	20	7	< 12
6019	RR Ophiuchi	R^2	217	16	43	11	— 19	17	8	< 11
6050	RS Scorpii	S^2	219	16	48	22	— 44	56	7	11-12
6053	SS Scorpii	R^3	...	16	48	46	— 32	28	7-8	9-10
6062	RR Scorpii	R^2	220	16	50	15	— 30	25	7-8	9-10
6071	RV Scorpii	V^2	221	16	51	47	— 33	27	6-7	7-8
6100	RV Herculis	V^2	222	16	56	45	+ 31	22	9	< 12
6101	RT Scorpii	T^2	...	16	56	48	— 36	40	9	13
6161	RT Herculis	T^2	224	17	06	46	+ 27	11	9	< 12
6170	RW Scorpii	W^2	225	17	08	18	— 33	19	9-10	14
6225	RS Herculis	S^2	228	17	17	31	+ 23	01	8	11
6331	RU Scorpii	U^2	230	17	35	06	— 43	42	9	13
6370	SV Scorpii	S^3	232§	17	41	36	— 35	40	9	< 11
6386	RY Scorpii	Y^2	233	17	44	16	— 33	40	7-8	9
6546	RS Sagittarii	S^2	241	18	10	59	— 34	08	6-7	7-8
6608	RV Sagittarii	V^2	244	18	21	21	— 33	23	8	12
6685	Y Lyrae	X	249	18	34	12	+ 43	52	10-11	< 12
6815	ST Sagittarii	S^3	...	18	55	55	— 12	54	7-8	< 10
6816	Z Lyrae	Y	256	18	56	00	+ 34	49	9	11
6888	RW Sagittarii	W^2	...	19	08	04	— 19	02	9-10	11
6892	RX Sagittarii	X^2	259	19	08	42	— 18	59	10	< 13

* R Mali. † S Mali. ‡ V Velorum. ¶ The "Companion" gives Z and R^2 Hydrae in the same position. ‖ This as well as No. 126 is given as S^2 Hydrae in the "Companion." § The "Companion" for 1902 gives this as Y^2 Scorpii and the declination as — 31° 40′; it calls the next star S^3.

Number according to Chandler.	Chandler's Third Catalogue and Astr. Nach. 3752.	"Annuaire."	"Compan-ion" No.	R. A. 1900.			Decl. 1900.		Magnitude.	
									Max.	Min.
				h	m	s	°	′		
6896	RS Lyrae	Z	261	19	09	18	+33	15	10	<12
6900*b*	RY Sagittarii	Y^2	...	19	10	01	−33	42	6	<11
7040	RT Aquilae	T^2	272	19	33	17	+11	29	9	<13
7085*a*	SU Cygni	T^3	275	19	40	49	+29	01	6-7	7-8
7085	RT Cygni	T^2	276	19	40	50	+48	32	7-8	10-11
7096	SY Cygni	V^3	277	19	42	43	+32	28	10	<12
7100	TU Cygni	W^3	278	19	43	19	+48	49	9	<13
7139	RR Sagittarii	R^2	284	19	49	43	−29	27	7-8	<12
7151	RU Sagittarii	U^2	286	19	51	50	−42	07	8	<13
7155	RR Aquilae	R^2	287	19	52	24	− 2	11	8-9	<12
7162	RS Aquilae	S^2	288	19	53	42	− 8	10	10	<12
...	... Cephei	R	...	19	56	59	+88	51	8	10
7223	SW Cygni	U^3	291	20	03	50	+46	01	8-9	11-12
7240	RY Cygni	Y^2	...	20	06	37	+35	39	8-9	9-10
7247	RX Cygni	X^2	...	20	07	46	+47	31	7-8	8-9
7248	RU Aquilae	U^2	295	20	08	03	+12	42	9	11
...	... Aquilae	τ^2	296	20	08	03	+12	42		
7259	RS Cygni	S^2	...	20	09	45	+38	28	6-8	8-10
7266	RT Sagittarii	τ^2	301	20	11	06	−39	25	7-8	<11
...	... Cygni	X^3	303	20	19	41	+42	55	10	12
7351	RW Cygni	W^2	...	20	25	12	+39	39	7-8	10-11
7378	SZ Cygni	Y^3	304	20	29	38	+46	16	8	9-10
7379	ST Cygni	S^3	305	20	29	55	+54	38	9	14
7380	TV Cygni	...	...	20	30	02	+46	13	9	9-10
...	... Capricorni	S	308	20	36	01	−19	24	9	11
7456	RR Cygni	R^2	317	20	42	37	+44	30	8-9	9-10
7492	RZ Cygni	Z^2	323	20	48	28	+46	59	9	13
7538	RR Capricorni	R^2	326	20	56	23	−27	29	9	<10
7594	RS Aquarii	S^2	333	21	05	45	− 4	27	9-10	<14
7619	RR Aquarii	R^2	335	21	09	49	− 3	19	8-9	13
7783	RU Cygni	U^2	342	21	37	19	+53	52	7-8	9
7793	SS Cygni	R^3	343	21	38	47	+43	08	7	11
7795	RV Cygni	V^2	...	21	39	08	+37	34	7-8	9

In view of the fact that the double letter notation has been adopted by the Variable Star Committee of the *Astronomische Gesellschaft*, it would seem best that all variable star observers should adopt this notation, and thus avoid the confusion which must necessarily follow if two systems be used. It is to be hoped also that the assignment of notation to individual stars will also be left entirely to the Committee. The provisional notation now used in the *Nachrichten* to designate newly discovered and suspected variables, using numerals in the order of discovery together with the year of discovery, as for example 3.1901, is entirely adequate to serve the purpose until the Committee shall have determined the variability of the star and assigned it permanent notation.

In the succeeding numbers of POPULAR ASTRONOMY we shall endeavor to follow consistently the notation adopted by the Committee.

A few stars are included in the list, which were found in the *Annuaire* but not in Chandler's Catalogue or the list of the Committee. These will be recognized by the blank in the first column.

THE LIGHT CURVE OF THE NEW STAR IN PERSEUS.

CONCLUDED FROM PAGE 257.

Guthnick, Dr. P., Bonn. *A. N.* 3775. The observations, from Feb. 25 to May 24 and from Aug. 19 to Sept. 29, were made partly with a Zöllner photometer (Ph) and partly by Argelander's method with the following instruments: I a 3½-inch refractor; II a telescope of 5cm aperture and magnifying power 12; III an opera glass of 3½cm aperture and a small astronomical telescope of 2cm aperture. The observation on Feb. 25 was made with the 13-inch refractor. The following color scale was adopted: 0.0 = white; 1.0 = yellowish white; 2.0 = whitish yellow; 3.0 = normal yellow; 4.0 = dark yellow; 5.0 = orange yellow; 6.0 = orange; 7.0 = reddish orange; 8.0 = orange red; 9.0 = red with little orange; 10.0 = red with less trace of orange.

The colors of the comparison stars on this scale were found to be:

α Aurigæ	Feb. 15	3.0	Mar. 1	3.0	Mar. 14	14.0		
α Tauri	Mar. 1	6.0	Mar. 6	6	Mar. 14	15.5	Mar. 1	6.3
	Mar. 14	6.0						
ρ Persei	Mar. 14	5.8	Mar. 21	6.0	Mar. 24	6.3	Mar. 29	5.8
	Apr. 2	6.5	Apr. 18	7.0	Apr. 20	6.5	Apr. 21	6.0
	Apr. 23	6.5						
α Orionis	Mar. 24	8.0						
ω Persei	Apr. 18	6.0						
σ Persei	Apr. 25	4.0						
α Bootis	May 28	3.8						
κ Persei	May 24	5						
BD 43°.730	Aug. 29	6	Sept. 1	4·8	Sept. 3	4.5		

The magnitudes were reduced to the Potsdam System.

	Gr. M. T.	Instrument.	Comparison Stars and Remarks.	Magnitude. Obs'r.	Magnitude. Reduced.	Color
Feb.	h					
15	22.8	13-in.	α Aur., α Pers. Bright daylight	1.14	0.88	1.0
16	6.0	—	α Aur., α Pers	1.60:	1.35:	
	7.7	—	α Can. Min., β Gem., α Pers.	1.05:	0.78:	
17	6.6	IV	α Pers.	1.67	1.43	3
	9.1	—	β Gem., α Pers., α Tauri	1.91	1.68	
Mar.						
1	8.1	II	α, β Pers., γ Orionis, β Tauri	2.31	2.08	4.3
3	10.0	—	α, β Pers.	2.49	2.27	5?
5	10.3	—	β Pers., β Tauri, γ Orionis	2.64	2.43	
6	10.6	—	ε, β, γ, δ Persei	3.08	2.88	7
7	6.5	—	γ, β, δ, ε	3.03	2.83	
	7.8	Ph	δ	2.81	2.61	
8	7.3	—	ε, δ, γ, β	3.05	2.85	
14	7.3	III, I	ν, δ	3.80	3.62	7.3
	8.2	III	ξ, ν, ζ	3.72	3.54	
	8.7	Ph	ζ, ν	3.71	3.53	
	10.3	III	ν	3.73	3.55	
11	7.5	III, I	ν, κ, *l*, ξ, ρ	3.84	3.66	7.9
	8.4	Ph	ζ, ν	4.05	3.88	
	9.0	III	ν, κ	3.82	3.64	
14	7.2	—, I	ν	4.38	4.22	7.5
	7.7	Ph	*l*, ν	4.24	4.08	
	8.1	III	ν, κ, ρ, *l*, ξ, ο	4.14	3.97	

	Gr. M. T.	Instrument.	Comparisons.	Magnitude. Obs'r.	Revised	Color
Mar.	h					
18	8.2	III	*l*, (72), ν, ξ	4.96	4.83	
	9.3	III	*l*, (72), (71), σ	5.30	5.18	
19	7.4	III, I	*l*, σ, (58)	4.85	4.71	8.0
	8.4	III	*l*	4.88	4.74	
	8.9	Ph	ν, *l*	4.85	4.71	
	9.3	III, I	ν, *l*	4.79	4.65	
30	9.0	III	ν, *l*, κ	4.51	4.36	
Apr.						
1	10.5	III, I	ν, *l*, κ	4.60	4.45	8
2	7.5	III, I	*l*, (72)	5.50	5.38	8.0
	9.9	III, I	(72), *l*	5.37	5.24	
4	9.7	III, I	*l*, ν, κ, ξ, σ	4.40	4.25	8.5
	10.5	Ph	ν, *l*	4.40	4.25	
	10.8	I, III	ν, κ	4.43	4.28	
5	7.7	III	ν, *l*	4.66	4.51	
7	7.8	III	(72), (71), *l*	5.73	5.62	
9	8.1	III	*l*, ν, ξ, κ	4.65	4.50	
18	7.7	III, I	*l*, ν, κ	4.40	4.25	6.6
	8.1	Ph	ν, *l*	4.36	4.20	
	8.5	III	*l*, ν, κ	4.41	4.26	
19	8.3	I, III	(72)	5.65	5.53	8.0
	8.8	Ph	*l*, (72)	5.82	5.71	
	9.2	I, III	*l*, (72)	5.65	5.53	
20	7.8	I	(72)	6.05	5.95	8.5
	8.3	Ph	*l*, (79)	5.80	5.69	
	8.7	III	*l*, (72), (71), (80), (79), (75)	5.84	5.73	
21	8.1	III, I	(72), (71), (83)	5.93	5.83	8.0
	8.4	Ph	*l*, (79)	5.84	5.73	
	8.8	III, I	(71), (72), (79), (75), (83)	5.98	5.88	
22	8.0	Ph, I	ν, κ, (72), (71), *l*, (79)	5.99	5.89	7.5
	8.2	III	(72), (71)	5.70	5.58	
	8.6	Ph	ν, κ, (72), (71), *l*, (79)	5.85	5.74	
	8.9	III	*l*, (74), (71), (75)	5.71	5.60	
	9.5	III	(72), (71)	5.65	5.54	
23	8.0	I	*l*	4.60	4.45	5.5
	8.4	Ph	ν, *l*, β, δ, γ	4.35	4.20	
	8.7	—, III	ν, *l*, κ	4.52	4.37	
	9.2	Ph	*l*, ν, β, δ, γ	4.25	4.09	
	9.3	III	*l*, ν, κ	4.47	4.32	
24	8.2	II, III	*l*	<5.1		7.5
	9.2	II, III	*l*, (72)	5.72	5.61	
25	8.4	III, I	(72)	6.08	5.98	7.5
	8.8	Ph	*l*, (79), ϵ, σ	6.15	6.05	
	9.4	I	(72)	6.03	5.93	
29	9.0	III	*l*, (72)	6.02	5.92	
May						
3	8.5	I, IV	*l*, (72)	5.74	5.63	7.0
	9.2	Ph	*l*, (79)	5.60	5.49	
4	8.8	Ph, I	*l*, (79), (72)	5.85	5.74	7.0
9	9.1	II	(72), (83)	6.15	6.05	
18	10.3	I	*l*, ν	4.88	4.74	6.5
20	9.3	II, I	(72)	5.99	5.89	
21	9.2	I	(72), (83)	6.08	5.98	7.5
22	9.8	I	*l*, ν, (71)	4.76	4.62	7.1
23	9.5	I	*l*, (72), (83)	5.90	5.80	
24	9.1	I	(72), (83), (85)	6.12	6.01	7.8

Ivanovski, M., Doubiago, Prof. D. J., Gratchef, M. A. and Mikhailovski, A. A., Kasan. *A. N.* 3775. The observations extend from Feb. 23 to Oct. 23, and the magnitudes of the comparison stars were taken from POPULAR ASTRONOMY, Oct 1901, p. 453 and 454, the column "Adopted Magnitude."

Date.	Gr. M. T.	Observer	Comparisons.	Mag.	Color.
1901	h				
Feb. 23	3.2	I		0.2	Blue
	6.2	I		0.0	Blue
24	8.2	D		0.5	
25	3.7	G	α Aurigæ 3 α Pers.	0.70	*
	4.1	G	α Orionis 1 ε Pers.	1.13	
	6.0	I	α Aur. 9 β Gem.; α Aur. 5 β Pers.; α Aur. 3 α Pers.	1.02	†
	6.4	M	α Orionis 6 α Gem.	1.33	
	7.0	M	β Orionis 4 α Leonis; α Can. min. 6 α Gem.	0.95	
	8.2	D	α Aur. 6.5 α	1.30	
	8.7	G	α Aur. 5 α	1.05	
26	2.5	G	α Aur. 7 α; N = β Gem.	1.30	PY
	3.5	I	α Aur. 6 α; β Gem. 2 α; α Aur. 7 β	1.35	
	4.6	M	α Aur. 9 α; α Tauri 6 α	1.63	
	5.7	I	α Aur. 8 α; α Aur. 6 β; N = β Gem.	1.36	‡
	5.8	D	α Aur. 6 α; α Tuuri 5 α	1.35	
27	4.3	G	β Gem. 5 α	1.55	
	5.1	I	α Aur. 8 α; α Aur. 6 β; β Gem. 7 α Gem. α Tauri 5 α	1.45	**
28	6.2	I		1.7	
Mar. 1	6.7	I	N = α	1.9	
5	4.7	I	α 4 ε; α Aur. 8 ε	2.35	
	7.3	I	α 4 ε; N = α Arietis; α 3 δ	2.24	O
	7.4	G	α 3 δ	2.25	
6	6.9	I	α 9 δ; α 7 δ; α 8 γ; N = δ Cass.	2.88	
11	5.3	I	α 9 δ; ε 5 δ; ε 2 ν	3.04	OR
	7.6	I	ε 7 δ	3.05	
	7.6	D	ε 7 δ	3.05	
13	4.7	I	δ 6 ν; ε 7 ν	3.62	
	7.3	D	δ 6.5 ν	3.64	
14	4.6	I	δ 9 ν; ε 9 ν; ο 4 ν	3.87	
	8.0	D	δ 7 ν	3.68	
	8.0	M	δ 6 ν	3.60	
15	6.2	I		3.9	
16	4.1	I	N = ν	3.93	
	4.6	M	N = ν	3.93	
	7.7	D	δ 3 ν	3.35	
20	6.4	I	δ 5 ν	3.52	
23	6.4	I	δ 8 ν	3.76	
26	7.7	I	N = σ; ν 5 ψ	4.33	
27	5.4	I	δ 7 ν	3.68	
	5.5	M	δ 2 *l*	3.49	
April 1	4.5	I	ν 8 σ; ν 5 ψ	4.27	OR
11	...	I		6.0	
16	7.0	I	(71) 2 (83); *l* 6 (83); (72) 4 (85)	5.78	
	9.7	I	(71) 2 (83); *l* 6 (83)	5.69	
17	7.0	I	(71) 1 (83); *l* 8 (72)	5.38	
20	8.1	I	(71) 3 (83); *l* 5 (85); σ 7 (83)	5.81	
	10.1	I	(71) 2 (83); σ 5 (83)	5.50	
21	7.7	I	(71) 6 (83); (71) 4 (85); (81) 5 (83)	6.06	
	9.7	I	(71) 8 (83); (71) 7 (85); (81) 8 (83)	6.30	
22	6.8	I	(71) 8 (83); *l* 6 (85); (72) 3 (88)	6.08	R

Date.	Gr. M. T.	Observer	Comparisons.	Mag.	Color.
1901	h				
	7.3	M	(71) 6 (85); (71) 8 (83)	6.21	
23	6.5	I	σ 8 (71); ν 6 (72); σ 6 *l*	4.86	Y
27	7.1	I	ψ 2 *l*; κ 4 (67); ν 5 (71); κ 3 (71)	4.46	O
28	7.0	I	σ 5 (71); N = *l*; ν 9 (72)	5.15	
29	5.8	I	(71) 7 (83); (72) 3 (85); *l* 4 (88)	5.94	R
	8.3	M	*l* 7 (83); (71) 5 (83); (83) 6 (85)	6.03	
30	7.4	I	(71) 8 (83); (72) 6 (85); *l* 5 (88)	6.20	
May 1	7.2	I	(71) 6 (83); *l* 5 (85); (72) 4 (86)	5.98	R
	9.2	M	(71) 7 (83); (72) 6 (83); *l* 8 (83)	6.03	R
3	6.0	I	(71) 2 (83); *l* 8 (72); σ 9.5 (72)	5.39	
	8.7	I	(71) 1 (83); N = (72); *l* 3 (83)	5.41	
7	7.1	I	(71) 1 (83); *l* 7 (72)	5.36	
10	6.9	I	(71) 8 (83); (72) 5 (85); (71) 4 (88)	6.14	R
11	7.2	I	N = (83); (72) 4 (88); (71) 6 (85)	6.25	
	10.6	I	(72) 6 (85); N = (83)	6.32	
13	7.3	I	ν 8 (72); σ 9 (71); ψ 7 *l*	5.05	
	9.7	I	N = (71); σ 8 (72)	5.28	
21	6.7	I	N = (83)	6.34	
21	7.0	I	(72) 8 (83); (71) 5 (85)	6.14	R_{3-4}
22	7.7	I	N = *l*, σ 9 (71)	5.15	Or_3
23	6.6	I	(72) 3 (83); (71) 4 (83); (72) 2 (85)	5.70	$(RO)_3$
24	7.5	I	(72) 8 (83); (71) 6 (85); (72) 5 (86)	6.16	$(RO)_4$
25	7.3	I	(72) 8 (83); *l* 6 (85); (71) 9 (83)	6.18	$(RO)_{3-4}$
26	7.4	I	N = (71); *l* 5 (72)	5.28	Or_3
30	7.0	I	σ 7 (72); σ 9 *l*; ψ 8.5 (71)	5.10	$(OrY)_2$
	8.4	I	σ 9 (71); N = *l*	5.15	$(OrY)_{2-3}$
June 1	7.5	I	(72) 7.5 (83); (71) 7 (85); (72) 6 (86)	6.30	Y_2
	9.9	I	(72) 9.5 (83); (71) 7 (86); (72) 7.5 (85)	6.44	Y_2
6	7.3	I	(71) 9 (83); N = (85)	6.57	$(RO)_3$
7	7.4	I	(71) 9 (83); (71) 8 (85)	6.41	Y_2
	10.1	I	(72) 7 (83); (71) 6 (85)	6.17	*
8	8.3	I	N = *l*; σ 9 (71)	5.15	Y_1G_3
9	8.3	I	(72) 6 (83); (71) 4 (85)	5.96	$(RO)_3$
11	7.5	I	*l* 8 (72) (71) 0.5 (83)	5.35	Y_1G_2
19	9.7	I	(72) 5 (83); (71) 4 (85)	5.92	Y_2
25	8.2	I	(72) 7 (83); (71) 5 (85)	6.14	Y_3G_2

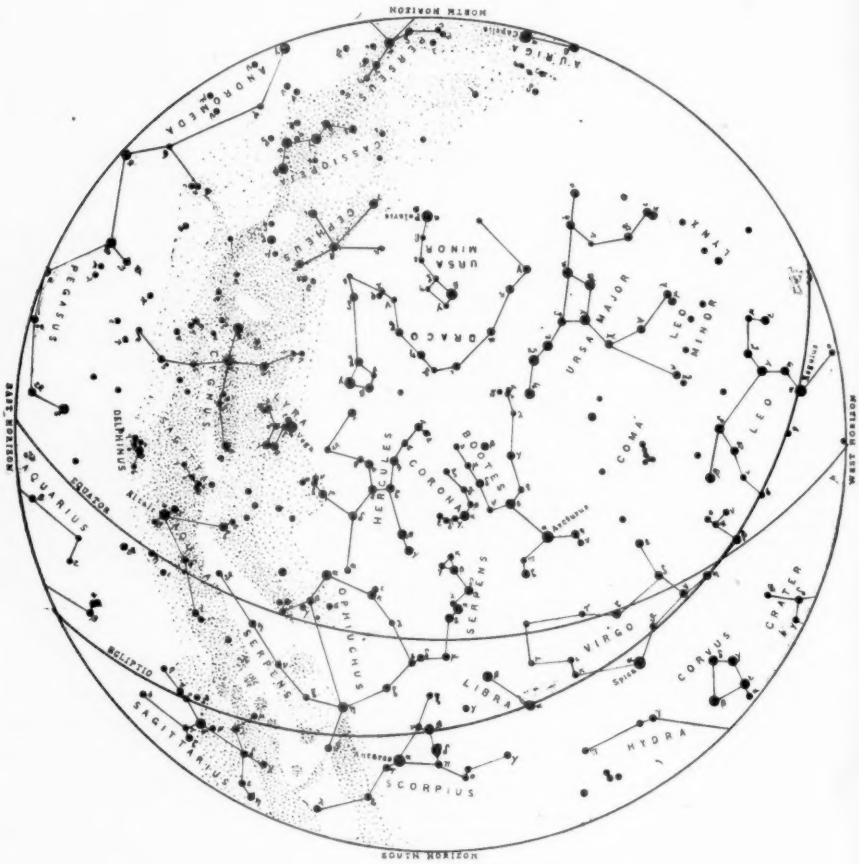
* Capella.

Mr. A. E. Evans of Sandusky, Ohio, writes, under date of May 5, 1902, that he, with his wife and daughter, observed Nova Persei on the night of Feb. 22, 1901, about 8 P. M., Central Standard Time, and that the Nova "was just about as bright as Aldebaran and as near the same color as two stars could well be, and they both looked rather red that night. I looked at them for a long time comparing them and watched them a good portion of the time until midnight, Nova Persei getting brighter all the time and also fading in color. When I saw it the next evening it was as bright as Capella or Arcturus, and its color a very pale yellow." The interesting point about these observations is the red color noted on Feb. 22. Other observers, so far as our records show, noted the color as pale yellow, white, or like that of Procyon. The observations were made without instrumental aid. Mr. Evans wrote a letter to Professor Payne on the evening of Feb. 22 and another on Feb. 23, 1901 in which the above statements were made, but these letters were overlooked in making up our collection of observations.

PLANET NOTES FOR JUNE, JULY AND AUGUST.

H. C. WILSON.

Mercury is visible as evening star during the first few days of June, and will be at inferior conjunction June 23. It will be at greatest elongation west from the Sun 20° 35′ on July 15 and so will be visible in the morning during the middle portion of that month. Superior conjunction will occur Aug. 11.



THE CONSTELLATIONS AT 9 P. M. JULY 1902.

Venus will be morning star during all of the summer, gradually diminishing in brightness and drawing into the morning twilight. Her brightness will be 92 on June 4, 73 July 4, and 62 Aug. 3 as compared with 203 on March 21.

Mars is too deep in the morning twilight to be observed yet; and is emerging very slowly. Toward the end of July observations may be begun, but will still be under very unsatisfactory conditions. On the morning of August 1 Mars and Venus will be in conjunction, the latter being 1° 18′ south of the former. About seven hours later the waning Moon will be in conjunction with the two planets, passing about 5° to to the south of Mars.

Jupiter may be observed after midnight, being visible toward the east of south in the constellation Capricorn. Jupiter begins his retrograde movement June 6 and will continue to move westward among the stars during the summer. The Moon will be in his vicinity June 24, July 21 and August 17. Jupiter will be at opposition Aug. 5.

Saturn comes to opposition July 17 and so may be observed during all the summer months. The Moon will be near Saturn June 23, July 20 and Aug. 16. Saturn's movement will be retrograde during the three months.

Uranus is near its best position for the year, coming to opposition June 10. It is to be found, with the aid of a telescope, among the faint stars at the foot of Ophiuchus, between Scorpio and Sagittarius, about 2° south and a little west of the star θ Ophiuchi.

Neptune is hidden in the rays of the Sun, being at superior conjunction June 23.

The Moon.

	Phases.		Rises. (Central Standard Time at Northfield Local Time 13m less.)		Sets.	
			h	m	h	m
June	5	New Moon	4	06 A. M.	7	20 P. M.
	12-13	First Quarter	11	57 "	12	21 A. M.
	20-21	Full Moon	7	35 P. M.	5	10 "
	27-28	Last Quarter	11	30 "	12	15 P. M.
July	5	New Moon	4	54 A. M.	7	57 "
	12	First Quarter	12	54 P. M.	11	50 "
	19-20	Full Moon	6	57 "	4	55 A. M.
	27-28	Last Quarter	11	10 "	1	31 P. M.
Aug.	3	New Moon	4	54 A. M.	7	13 "
	10	First Quarter	12	42 P. M.	10	56 "
	18-19	Full Moon	6	40 "	5	49 A. M.
	25-26	Last Quarter	10	35 "	1	36 P. M.

Occultations Visible at Washington.

Date. 1902.	Star's Name.	Magnitude.	IMMERSION. Washington M.T. h	m	Angle from N pt. °	EMERSION. Washington M. T. h	m	Angle from N pt. °	Duration. h	m
June 11	36 Sextantis	6.6	11	40	133	12	29	265	0	49
16	α^1 Librae	6.3	14	23	59	15	12	314	0	49
16	α^2 Librae	2.9	14	26	70	15	21	303	0	55
25	B.A.C. 7177	6.9	8	58	105	9	47	226	0	49
July 1	B.A.C. 1119	6.4	14	50	126	15	24	205	0	34
7	ω Leonis	5.6	9	21	99	10	09	295	0	48
23	B.A.C. 7951	6.7	9	41	28	10	29	292	1	48
23	Lalande 44872	7.0	15	55	54	17	15	249	0	20
Aug. 10	ν^2 Librae	6.9	11	45	103	12	43	267	0	58
10	ν^1 Librae	5.4	11	47	46	12	25	325	0	38
18	c^2 Capricorni	6.2	10	36	35	11	50	276	1	14
26	*m* Tauri	5.1	16	19	75	17	36	270	1	17

Phenomena of Jupiter's Satellites.

Central Standard Time.

		h	m			
July	2	12	49 A. M.	I	Sh. In.
		1	38 "	I	Tr. In.
		3	09 "	I	Sh. Eg.
		3	58 "	I	Tr. Eg.
		3	58 "	II	Sh. In.
		10	08 P. M.	I	Ec. Dis.
	3	1	14 A. M.	I	Oc. Re.
		9	37 P. M.	I	Sh. In.
		10	24 "	I	Tr. Eg.
		10	26 "	II	Ec. Dis.
	4	2	50 A. M.	II	Oc. Re.
	5	9	39 P. M.	II	Tr. Eg.
	8	1	42 A. M.	III	Oc. Re.
	9	2	43 "	I	Sh. In.
		3	23 "	I	Tr. In.
	10	12	03 "	I	Ec. Dis.
		3	00 "	I	Oc. Re.
		9	11 P. M.	I	Sh. In.
		9	49 "	I	Tr. In.
		11	31 "	I	Sh. Eg.
	11	12	09 A. M.	I	Tr. Eg.
		12	14 "	IV	Oc. Re.
		1	00 "	II	Ec. Dis.
		9	26 P. M.	I	Oc. Re.
	12	9	02 "	II	Tr. In.
		10	50 "	II	Sh. Eg.
		11	58 "	II	Tr. Eg.
	14	11	16 "	III	Ec. Dis.
	17	1	57 A. M.	I	Ec. Dis.
		11	05 P. M.	I	Sh. In.
		11	33 "	I	Tr. In.
	18	1	25 A. M.	I	Sh. Eg.
		1	53 "	I	Tr. Eg.
		8	26 P. M.	I	Ec. Dis.
		11	10 "	I	Oc. Re.
		11	18 "	IV	Sh. In.
	19	3	14 A. M.	IV	Tr. In.
		4	07 "	IV	Sh. Eg.
		8	19 P. M.	I	Tr. Eg.
		10	30 "	II	Sh. In.
		11	20 "	II	Tr. In.
	20	1	28 A. M.	II	Sh. Eg.
		2	16 "	II	Tr. Eg.
	21	8	30 P. M.	II	Oc. Re.
	22	3	18 A. M.	III	Ec. Dis.
	25	12	59 "	I	Sh. In.
		1	18 "	I	Tr. In.
		3	19 "	I	Sh. Eg.
		3	37 "	I	Tr. Eg.
		8	46 P. M.	III	Sh. Eg.
		9	52 "	III	Tr. Eg.
		10	20 "	I	Ec. Dis.
	26	12	55 A. M.	I	Oc. Re.
		9	48 P. M.	I	Sh. Eg.
		10	02 "	I	Tr. Eg.
	27	1	51 A. M.	II	Sh. In.
		1	36 "	II	Tr. In.
		7	28 P. M.	II	Ec. Dis.
		10	44 "	II	Oc. Re.

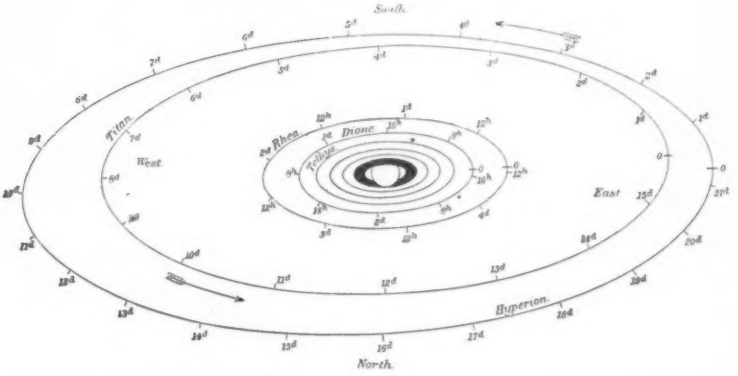
		h	m			
Aug.	1	2	54 A. M.	I	Sh. In.
		3	00 "	I	Tr. In.
		9	04 P. M.	III	Sh. In.
		9	26 "	III	Tr. In.
	2	12	15 A. M.	I	Ec. Dis.
		12	46 "	III	Sh. Eg.
		1	08 "	III	Tr. Eg.
		2	38 "	I	Oc. Re.
		9	22 P. M.	I	Sh. In.
		9	26 "	I	Tr. In.
		11	42 "	I	Sh. Eg.
		11	46 "	I	Tr. Eg.
	3	9	04 "	I	Oc. Re.
	4	10	01 "	II	Oc. Dis.
		10	19 "	IV	Sh. Eg.
		10	30 "	IV	Tr. Eg.
	5	2	57 A. M.	II	Oc. Re.
	6	7	55 P. M.	II	Tr. Eg.
		7	59 "	II	Sh. Eg.
	9	12	42 A. M.	III	Tr. In.
		1	04 "	III	Sh. In.
		2	02 "	I	Oc. Dis.
		11	10 P. M.	I	Tr. In.
		11	17 "	I	Sh. In.
	10	1	30 A. M.	I	Tr. Eg.
		1	37 "	I	Sh. Eg.
		8	28 P. M.	I	Oc. Dis.
		10	55 "	I	Ec. Re.
	11	7	55 "	I	Tr. Eg.
		8	06 "	I	Sh. Eg.
	12	12	15 A. M.	II	Oc. Dis.
		3	28 "	II	Ec. Re.
		11	55 P. M.	IV	Oc. Dis.
	13	7	15 "	II	Tr. In.
		7	40 "	II	Sh. In.
		10	11 "	II	Tr. Eg.
	17	12	53 A. M.	I	Tr. In.
		1	11 "	I	Sh. In.
		3	14 "	I	Tr. Eg.
		3	32 "	I	Sh. Eg.
		10	12 P. M.	I	Oc. Dis.
	18	12	50 A. M.	I	Ec. Re.
		7	19 P. M.	I	Tr. In.
		7	40 "	I	Sh. In.
		9	40 "	I	Tr. Eg.
		10	00 "	I	Sh. Eg.
	19	2	29 A. M.	II	Oc. Dis.
		7	18 P. M.	I	Ec. Re.
		10	51 "	II	Ec. Re.
	20	9	30 "	II	Tr. In.
		10	17 "	II	Sh. In.
	21	12	27 A. M.	II	Tr. Eg.
		1	13 "	II	Sh. Eg.
	22	7	22 P. M.	II	Ec. Re.
	24	11	57 "	I	Oc. Dis.
	25	9	04 "	I	Tr. In.
		9	35 "	I	Sh. In.
		11	25 "	I	Tr. Eg.
		11	55 "	I	Sh. Eg.

Phenomena of Jupiter's Satellites.—Continued.

	h	m				h	m		
Aug. 26	9	04	"	III	Oc. Dis.	Aug. 29	7	14 P. M.	IV	Oc. Re.
	9	13	"	I	Ec. Re.		8	00 "	IV	Ec. Dis.
27	11	47	"	II	Tr. In.		9	58 "	II	Ec. Re.
28	12	54 A. M.		II	Sh. In.	30	12	42 A. M.	IV	Ec. Re.

NOTE.—In. denotes ingress; Eg., egress; Dis., disappearance; Re., reappearance; Ec., eclipse; Oc., occultation; Tr., transit of the satellite; Sh., transit of the shadow.

The Satellites of Saturn.



APPARENT ORBITS OF THE SEVEN INNER SATELLITES OF SATURN, AT OPPOSITION IN 1902 AS SEEN IN AN INVERTING TELESCOPE.

I. MIMAS.

Period $0^d\ 22^h.6$.

		h	
July	2	12.7 A. M.	W
	2	11.3 P. M.	W
	3	9.9 "	W
	4	8.5 "	W
	9	2.3 A. M.	E
	10	12.9 "	E
	10	11.5 P. M.	E
	11	10.1 "	E
	12	8.7 "	E
	13	7.4 "	E
	17	2.5 A. M.	W
	18	1.1 "	W
	18	11.7 P. M.	W
	19	10.3 "	W
	20	9.0 "	W
	21	7.6 "	W
	25	2.7 A. M.	E
	26	1.3 "	E
	26	11.9 P. M.	E
	27	10.6 "	E
	28	9.2 "	E
	29	7.8 "	E
Aug.	3	1.5 A. M.	W

I. MIMAS, Cont

		h	
Aug.	4	12.2 "	W
	4	10.8 P. M.	W
	5	9.4 "	W
	6	8.0 "	W
	11	1.8 A. M.	E
	12	12.4 "	E
	12	11.0 P. M.	E
	13	9.6 "	E
	14	8.3 "	E
	20	12.6 A. M.	W
	20	11.3 P. M.	W
	21	9.9 "	W
	22	8.5 "	W
	23	7.1 "	W
	28	11.5 "	E
	29	10.1 "	E
	30	8.7 "	E
	31	7.3 "	E

II. ENCELADUS.

Period $1^d\ 8^h.9$.

		h	
July	2	3.1 P. M.	E
	3	11.9 "	E

II. ENCELADUS. Cont

		h	
July	5	8.8 A. M.	E
	6	5.7 P. M.	E
	8	2.6 A. M.	E
	9	11.4 "	E
	10	8.3 P. M.	E
	12	5.2 A. M.	E
	13	2.1 P. M.	E
	14	10.9 "	E
	16	7.8 A. M.	E
	17	4.7 P. M.	E
	19	1.6 A. M.	E
	20	10.3 "	E
	21	7.3 P. M.	E
	23	4.2 A. M.	E
	24	1.1 P. M.	E
	25	10.0 "	E
	27	6.8 A. M.	E
	28	3.7 P. M.	E
	30	12.6 A. M.	E
	31	9.5 "	E
Aug.	1	6.3 P. M.	E
	3	3.2 A. M.	E
	4	12.9 P. M.	E
	5	8.9 "	E

The Satellites of Saturn.—Continued.

II. ENCELADUS, Cont.

		h	
Aug.	7	5.8 A. M.	E
	8	2.7 P. M.	E
	9	11.6 "	E
	11	8.5 A. M	E
	12	5.3 P. M.	E
	14	2.2 A. M.	E
	15	11 1 "	E
	16	8.0 P. M.	E
	18	4.9 A. M.	E
	19	1.7 P. M.	E
	20	10.6 "	E
	22	7.5 A. M.	E
	23	4.4 P. M.	E
	25	1.3 A. M.	E
	26	10.1 "	E
	27	7.0 P. M.	E
	29	3.9 A. M.	E
	30	12.8 P. M.	E
	31	9.7 "	E

III. TETHYS.

Period 1^d $21^h.3$.

		h	
July	1	6.0 A. M.	E
	3	3.3 "	E
	5	12.6 "	E
	6	9.9 P. M.	E
	8	7.1 "	E
	10	4.4 "	E
	12	1.7 "	E
	14	11.0 A. M.	E
	16	8.3 "	E
	18	5.6 "	E
	20	2.9 "	E
	22	12.2 "	E
	23	9.5 P. M.	E
	25	6.7 "	E
	27	4.0 "	E
	29	1.3 "	E
	31	10.6 A. M.	E
Aug.	2	7.9 "	E
	4	5.2 "	E
	6	2.5 "	E
	7	11.8 P. M.	E
	9	9.1 "	E
	11	6.4 "	E
	13	3.7 "	E
	15	12.9 "	E
	17	10.2 A M.	E

III. TETHYS, Cont.

		h	
Aug.	19	7.5 "	E
	21	4.8 "	E
	23	2.1 "	E
	24	11.4 P. M.	E
	26	8.7 "	E
	28	6.0 "	E
	30	3.3 "	E

IV. DIONE.

Period 2^d $17^h.7$

		h	
July	2	4.4 A. M.	E
	4	10.1 P. M.	E
	7	3.7 "	E
	10	11.4 A. M.	E
	13	3.0 "	E
	15	8.7 P. M.	E
	18	2.3 "	E
	21	8.0 A. M.	E
	24	1.6 "	E
	26	7.3 P. M.	E
	29	12.9 "	E
Aug.	1	6.5 A. M.	E
	4	12.2 "	E
	6	5 9 P. M.	E
	9	11.5 A. M.	E
	12	5.2 "	E
	14	10.8 P M.	E
	17	4.5 "	E
	20	10.1 A. M.	E
	23	3 8 "	E
	25	9.5 P. M.	E
	28	3.1 "	E
	31	8.8 A. M.	E

V. RHEA.

Period 4^d $12^h.5$.

		h	
June	30	10 0 P. M.	E
July	5	10.3 A. M.	E
	9	10.6 P. M.	E
	14	10.9 A. M.	E
	18	11.3 P. M.	E
	23	11.5 A. M.	E
	27	11.9 P. M.	E
Aug.	1	12.2 "	E
	6	12.5 A. M.	E
	10	12.8 P. M.	E
	15	1.2 A. M.	E

V. RHEA, Cont.

		h	
Aug.	19	1.5 P. M.	E
	24	1.9 A. M.	E
	28	2.2 P. M.	E

VI. TITAN.

Period 15^d $23^h.3$.

		h	
June	28	8.8 A. M.	S
July	3	7.5 "	E
	7	9 3 "	I
	11	9.4 "	W
	15	6.1 "	S
	19	4.8 "	E
	23	6.9 "	I
	27	6.7 "	W
	31	3.3 "	S
Aug.	4	2.1 "	E
	8	4.2 "	I
	12	4.2 "	W
	16	12.9 "	S
	19	11.8 P. M.	E
	24	1.9 A. M.	I
	28	2.0 "	W
	31	10.8 P. M.	S

VII. HYPERION.

Period 21^d $07^h.6$.

June	30.2	I
July	6.2	W
	12.1	S
	16.7	E
	21.4	I
	27.4	W
Aug.	2.3	S
	6.9	E
	11.5	I
	17.6	W
	23.5	S
	28 0	E

VIII. IAPETUS.

Period 79^d $22^h.1$.

June	22 6	W
July	12.5	S
	31 2	E
Aug.	19.3	I
Sept.	8.7	W

COMET AND ASTEROID NOTES.

Discovery of a New Comet, *a* 1902 (Brooks).—While sweeping the eastern morning sky on April 14, I discovered a new comet in the constellation Pegasus. Position, R. A. 22^h 55^m 40^s; Decl. north 29° 12′.

An observation secured this morning, April 15, at 16 hours Standard mean time, gave the comet's approximate place, R. A. 23^h 8^m 10^s + 27° 25′. This shows a present daily motion of 12 minutes east and 2 degrees south. The

comet is fairly bright telescopic, with a minute stellar nucleus and a short tail. It is a curious fact that this comet was found in the same telescopic field in which my comet of Feb. 23, 1883 was discovered. WILLIAM R. BROOKS.

SMITH OBSERVATORY, Geneva, N. Y.,
April 16, 1902.

The following positions of the comet have been received by telegraph through the courtesy of Harvard College Observatory:

Observatory.	Gr. M. T.	R. A. h m s	Decl. ° ′ ″	Observer.
Koenigsberg	Apr. 16.5521	23 15 41.1	+ 26 06 35	Postelmann
Lick	16.9946	23 21 07.7	+ 25 12 26	Aitken

The following elements and ephemeris were cabled from Kiel, Germany:

ELEMENTS.

$T = 1902$ May 7, Gr. M. T.
$\omega = 228° \ 23'$
$\Omega = 52 \ 15$ } 1902.0
$i = 66 \ 30$
$q = 0.4512$

EPHEMERIS.

Gr. Midn.	R. A. h m s	Decl. ° ′	Light.
Apr. 27	1 22 20	+ 1 30	1.41
May 1	1 47 24	− 4 36	
5	2 25 08	− 7 58	
9	2 46 36	− 9 07	0.71

Later elements were telegraphed by Professor Leuschner of Berkeley, California. These are referred to the equator and were computed by Messrs. Stebbins, Curtiss, Weymouth and Leuschner. They depend on two observations on April 16 and a pointing of the telescope upon the comet at Lick Observatory on April 17, and so are quite uncertain. The period of 0.88 years is so improbable also, as to throw discredit upon the elements. It is stated in the telegram that another solution gives hyperbolic elements. Unfortunately the motion of the comet carried it quickly into the vicinity of the Sun so that observations have been impossible, none having come to hand of later date than April 18.

According to the ephemeris the comet should now be visible in the southern hemisphere. Professor Pickering writes that a cablegram received from Arequipa states that the comet was looked for (probably May 2) and not seen owing to twilight.

ELEMENTS.

$T =$ May 28.39 Gr. M. T.
$\omega = 274° \ 30'$ $\quad q = 0.5542$
$\Omega = 35 \ 03$ $\quad e = 0.3947$
$i = 61 \ 50$ $\quad$ Period = 0.88 years

EPHEMERIS.

Gr. Midn.	R. A. h m s	Decl. ° ′	Light.
May 1	1 54 08	− 5 26	2.09
5	2 20 52	− 9 55	
9	2 41 08	− 12 20	
13	2 57 12	− 13 25	1.07

The latest elements received, and probably the most accurate, are found in the *Astronomische Nachrichten* No. 3790. They were computed by Drs. E. Strömgren and H. Kreutz, of Kiel, and depend upon the Königsberg observation April 16 and two at Arcetri April 17 and 18.

$T = 1902$ May 7.159 Berlin M. T.
$\omega = 228° \ 22'.7$
$\Omega = 52 \ 15.4$
$i = 66 \ 30.4$
$\log q = 9.65436$

The following ephemeris, computed from the elements by Mr. M. Ebell, shows that the comet will not be visible again in the northern hemisphere but that it may possibly be detected in the southern latitudes:

EPHEMERIS OF COMET *a* 1902.

	R. A.			Decl.			log *r*.	log Δ.	Light.
	h	m	s	°	′				
April 27	1	21	58	+1	34.1		9.7103	9.7424	1.41
May 1	1	57	07	−4	33.4		9.6755	9.8069	1.22
5	2	24	53	−7	56.7		9.6563	9.8777	0.97
9	2	46	25	−9	06.8		9.6582	9.9453	0.71
13	3	03	15	−8	47.5		9.6806	0.0050	0.48
17	3	16	45	−7	37.5		9.7172	0.0560	0.32
21	3	27	59	−6	03.8		9.7608	0.0987	0.22

New Asteroids.—The following new asteroids have been discovered since our last note:

				Local M. T.			R. A.		Decl.		
					h	m	h	m	°	′	″
1902	HV	Wolf	Heidelberg	Mar. 10	13	54.9	12	52.7	− 9	07	11.5
"	"	"	"	Apr. 4	10	00.0	12	35.8	− 6	38	...
	HW	"	"	Mar. 6	9	54.7	5	31.0	+28	59	12.5

EPHEMERIS OF EROS.

Washington M. T.			α			δ			Log *r*	Log Δ
1902	h	m	h	m	s	°	′	″		
Oct. 8	15	7	9	26	5.70	+20	34	7.30	0.0657940	0.1240666
" 12	4	16	9	38	56.49	+19	7	9.33	0.0636620	0.1201828
" 15	17	25	9	51	33.69	+17	36	33.36	0.0617258	0.1165480
" 19	5	50	10	3	53.17	+16	3	22.96	0.0600080	0.1131038
" 22	18	14	10	16	1.10	+14	27	16.49	0.0585014	0.1098450
" 26	6	7	10	27	54.0	+12	49	11.12	0.0572224	0.1067493
" 29	18	0	10	39	36.4	+11	8	54.02	0.0561662	0.1038177
Nov. 2	5	28	10	51	6.10	+ 9	27	12.43	0.0553434	0.1010435
" 5	16	56	11	2	26.52	+ 7	44	1.49	0.0547522	0.0984315
" 9	4	16	11	13	37.81	+ 5	59	50.40	0.0543970	0.0959219
" 12	15	43	11	24	22.2	+ 4	16	47.44	0.0542785	0.0947083
" 16	2	54	11	35	38.15	+ 2	29	15.22	0.0543970	0.0913111
" 19	14	13	11	46	29.25	+ 0	43	24.72	0.0547522	0.0891587
" 23	1	44	11	57	16.36	− 1	2	35.61	0.0553430	0.0871037
" 26	13	13	12	7	58.83	− 2	48	15.48	0.0561664	0.0851154
" 30	1	6	12	18	40.08	− 4	33	45.80	0.0572228	0.0831664
Dec. 3	12	57	12	29	17.40	− 6	18	18.73	0.0585014	0.0812836
" 7	1	22	12	39	56.27	− 8	2	25.41	0.0600084	0.0793870
" 10	13	46	12	50	32.3	− 9	45	3.56	0.0617258	0.0775324
" 14	2	56	13	1	11.95	−11	26	54.63	0.0636624	0.0756586
" 17	1	65	13	11	49.57	−13	6	46.37	0.0657938	0.0738205
" 21	6	4	13	22	33.83	−14	45	42.60	0.0681354	0.0718447
" 24	20	5	13	33	16.07	−16	22	6 72	0.0706530	0.0699066
" 28	11	8	13	44	6.49	−17	57	18.56	0.0733678	0.0677631
1903.										
Jan. 1	2	10	13	54	55.3	−19	29	35.87	0.0762388	0.0655949
" 4	18	24	14	5	52.41	−21	0	11.82	0.0792944	0.0632653
" 8	10	38	14	16	48.45	−22	27	37.47	0.0824822	0.0608265
" 12	4	13	14	27	53.59	−23	53	4.71	0.0858408	0.0581962
" 15	21	48	14	38	57.7	−25	15	7.30	0.0893076	0.0553931
" 19	16	51	14	50	10.73	−26	34	51.93	0.0929296	0.0523762
" 23	11	55	15	1	21 37	−27	50	56.33	0.0966360	0.0491411
" 27	8	33	15	12	40.44	−29	4	35.28	0.1004806	0.0455798
" 31	5	12	15	23	53.91	−30	14	16.77	0.1043858	0.0417884
Feb. 4	3	33	15	35	15.39	−31	21	27.08	0.1084122	0.0376144
" 8	1	55	15	46	28.70	−32	24	35.72	0.1124754	9.0331754

F. E. SEAGRAVE.

VARIABLE STARS.

Minima of Variable Stars of the Algol Type.

[Greenwich Mean Time beginning with midnight. The hours greater than 12 are those of the afternoon. To obtain Eastern Standard time subtract 5 hours; for Central Standard subtract 6 hours, etc. For lack of space we give this month only the alternate minima, except in the case of S Antliæ for which every tenth minimum and S Cancri for which each minimum is given.]

U Cephei.

	d	h
June	1	20
	6	19
	11	19
	16	19
	21	18
	26	18
July	1	18
	6	17
	11	17
	16	17
	21	16
	26	16
	31	16
Aug.	5	15
	10	15
	15	15
	20	14
	25	14
	30	14

Algol.

June	27	0
July	2	18
	8	12
	14	5
	19	23
	25	17
	31	10
Aug.	6	4
	11	21
	17	15
	23	9
	29	2

λ Tauri.

July	2	15
	10	13
	18	10
	26	8
Aug.	3	6
	11	4
	19	1
	26	23

S Cancri.

June	9	22
	18	9
	28	21
July	8	8
	17	20
	27	8

S Antliæ.

Period $7^h\ 46^m.8$

June	2	10
	5	16
	8	21
	12	3
	15	9
	18	15
	21	21
	25	2
	28	8
July	1	14
	4	20
	8	2
	11	7
	14	13
	17	19
	21	1
	24	7
	27	12

δ Libræ.

June	4	17
	9	9
	14	0
	18	16
	23	8
	27	23
July	2	15
	7	7
	11	23
	16	14
	21	6
	25	22
	30	14
Aug.	4	5
	8	21
	13	12
	18	4
	22	20
	27	12

U Coronæ.

June	5	0
	11	21
	18	19
	25	17
July	2	14
	9	12
	16	10
	23	8
	30	5

U Coronæ Con.

	d	h
Aug.	6	3
	13	1
	19	22
	26	20

U Ophiuchi.

June	3	14
	5	6
	6	23
	8	15
	10	8
	12	0
	13	16
	15	8
	17	1
	18	17
	20	9
	22	1
	23	18
	25	10
	27	2
	28	18
	30	11
July	2	3
	3	19
	5	11
	7	4
	8	20
	10	12
	12	4
	13	21
	15	13
	17	5
	18	21
	20	14
	22	6
	23	22
	25	14
	27	7
	28	23
	30	15
Aug.	1	8
	3	0
	4	16
	6	8
	8	0
	9	17
	11	9
	13	1
	14	17
	16	10

U Ophiuchi Con.

	d	h
Aug.	18	2
	19	18
	21	10
	23	3
	24	19
	26	11
	28	3
	29	20
	31	12

Z Herculis.

June	2	17
	6	17
	10	16
	14	16
	18	16
	22	16
	26	16
	30	15
July	4	15
	8	15
	20	15
	24	14
	28	14
Aug.	1	14
	5	14
	9	14
	13	14
	17	13
	21	13
	25	13
	29	13

RX Herculis.

June	6	4
	7	23
	9	17
	11	12
	13	7
	15	2
	16	20
	18	15
	20	10
	22	5
	23	23
	25	18
	27	13
	29	7
July	1	2
	2	21
	4	15
	6	10

RX Hercu. Con.

	d	h
July	8	5
	9	23
	11	18
	13	13
	15	7
	17	2
	18	21
	20	15
	22	10
	24	5
	25	23
	27	18
	29	13
	31	7
Aug.	2	2
	3	21
	5	15
	7	10
	9	5
	10	23
	12	18
	14	13
	16	7
	18	2
	19	21
	21	16
	23	10
	25	5
	27	0
	28	19
	30	13

SY (V^3) Cygni

June	11	9
	23	10
July	5	10
	17	10
	29	11
Aug.	10	11
	22	11

SW (U^3) Cygni.

June	6	22
	16	1
	25	5
July	4	8
	13	12
	22	15
	31	19
Aug.	9	22
	19	2
	28	5

Minima of Variable Stars of the Algol Type.—Continued.

W Delphini.			W Delphini Con.			Y Cygni Con.			Y Cygni Con.			Y Cygni Con.		
	d	h		d	h		d	h		d	h		d	h
			Aug.	20	16				July	10	2	Aug.	6	1
June	4	19		30	7	June	16	3		13	3		9	1
	14	9	Y Cygni.				19	2		16	2		12	1
	24	0					22	2		19	2		15	1
July	3	15	June	1	3		25	2		22	2		18	1
	13	6		4	3		28	2		25	1		21	1
	22	20		7	3	July	1	2		28	1		24	1
Aug.	1	11		10	3		4	2		31	1		27	0
	11	2		13	3		7	2	Aug.	3	1		30	0

Variable Stars of Short Period not of the Algol Type.

	Minimum.			Maximum.				Minimum.			Maximum.		
			h			h				h			h
W Sagittarii	Jun	1	2	June	5	2	δ Cephei	June	28	4	June	29	19
δ Cephei		1	8		2	23	X Sagittarii		28	2		30	23
T Vulpeculæ		1	23		3	8	T Vulpeculae		28	14		29	23
X Cygni		2	4		7	23	Y Sagittarii		28	15		30	10
U Sagittarii		2	23		5	22	S Sagittae		29	5	July	1	15
S Sagittæ		4	1		7	11	W Virginis		29	6		7	10
Y Sagittarii		5	12		7	7	Y Ophiuchi		29	14		5	19
β Lyrae		5	21		8	23	η Aquilae		29	15		1	21
T Vulpeculae		6	9		7	18	U Sagittarii		29	22		2	21
U Aquilae		6	2		8	6	W Sagittarii	July	1	11		4	11
δ Cephei		6	17		8	8	β Lyrae		1	17		4	19
X Sagittarii		7	1		9	22	T Vulpeculae		3	0		4	9
η Aquilae		8	3		10	9	δ Cephei		3	13		5	4
W Sagittarii		8	16		11	16	U Aquilae		4	4		6	8
U Sagittarii		9	17		12	16	Y Sagittarii		4	9		6	4
T Vulpeculae		10	20		12	5	X Cygni		4	22		11	17
Y Sagittarii		11	7		13	2	X Sagittarii		5	2		8	0
β Lyrae		11	8		15	17	U Sagittarii		6	16		9	15
W Virginis		11	23		20	3	η Aquilae		6	19		8	25
δ Cephei		12	1		13	16	T Vulpeculae		7	10		8	19
S Sagittae		12	11		15	21	S Sagittae		7	14		11	0
Y Ophiuchi		12	11		18	16	β Lyrae		8	4		11	13
U Aquilae		13	3		15	7	δ Cephei		8	21		10	12
X Sagittarii		14	1		16	22	W Sagittarii		9	1		12	1
T Vulpeculae		15	6		16	15	Y Sagittarii		10	4		11	23
η Aquilae		15	17		17	13	U Aquilae		11	5		13	9
W Sagittarii		16	6		19	6	T Vulpeculae		11	21		13	6
U Sagittarii		16	11		19	10	U Sagittarii		13	10		16	6
Y Sagittarii		16	1		18	20	η Aquilae		14	0		16	9
δ Cephei		17	10		19	1	δ Cephei		14	6		15	21
X Cygni		18	13		25	8	β Lyrae		14	15		17	17
β Lyrae		18	19		21	21	Y Sagittarii		15	22		17	17
T Vulpeculae		19	17		21	2	S Sagittae		15	23		19	9
T Monocerotis		17	1		26	23	T Monocerotis		16	1		23	23
U Aquilae		20	3		22	7	T Vulpeculae		16	7		17	16
S Sagittae		20	20		24	6	W Sagittarii		16	15		19	15
X Sagittarii		21	2		23	23	Y Ophiuchi		16	17		22	22
η Aquilae		22	11		24	17	U Aquilae		18	5		20	9
δ Cephei		22	19		24	10	X Sagittarii		19	3		22	0
Y Sagittarii		22	20		24	15	δ Cephei		19	15		21	6
U Sagittarii		23	4		26	3	U Sagittarii		20	4		23	3
W Sagittarii		23	21		26	21	W Virginis		20	4		28	8
T Vulpeculae		24	3		25	12	T Vulpeculae		20	18		22	3
β Lyrae		25	6		28	15	β Lyrae		21	22		24	11
U Aquilae		27	4		29	8	η Aquilae		21	4		23	10

Variable Stars of Short Period not of the Algol Type.—Continued

	Minimum.	h	Maximum.	h
X Cygni	July 21	7	July 28	2
Y Sagittarii	21	17	23	12
W Sagittarii	24	6	27	6
S Sagittae	24	9	27	19
δ Cephei	25	0	26	15
T Vulpeculae	25	4	26	13
U Aquilae	25	6	27	10
X Sagittarii	26	3	29	0
U Sagittarii	26	22	29	21
Y Sagittarii	27	11	29	6
β Lyrae	27	13	30	15
η Aquilae	28	8	30	14
T Vulpeculae	29	15	31	0
δ Cephei	30	9	Aug. 2	0
W Sagittarii	31	20	3	20
U Aquilae	Aug. 1	7	3	11
S Sagittae	1	18	5	4
X Sagittarii	2	3	5	0
Y Sagittarii	2	6	4	1
U Sagittarii	2	16	5	15
W Virginis	2	19	10	23
Y Ophiuchi	2	20	9	1
β Lyrae	4	0	6	9
T Vulpeculae	3	1	4	10
W Geminorum	4	12	7	3
η Aquilae	4	12	6	18
δ Cephei	4	17	6	8
X Cygni	6	17	13	12
T Vulpeculae	7	12	8	21
Y Sagittarii	8	0	9	19
U Aquilae	8	7	10	11
W Sagittarii	8	10	11	10
X Sagittarii	9	4	12	1
U Sagittarii	9	9	12	8
β Lyrae	9	11	12	13
δ Cephei	10	2	11	17
S Sagittae	10	3	13	13
η Aquilae	11	17	13	23
T Vulpeculae	11	22	13	7

	Minimum.	h	Maximum.	h
T Monocerotis	Aug. 12	2	Aug. 20	0
W Geminorum	12	6	14	21
Y Sagittarii	13	19	15	14
ζ Geminorum	15	0	20	0
U Aquilae	15	8	17	12
δ Cephei	15	11	17	2
β Lyrae	15	22	19	7
W Sagittarii	16	0	19	0
U Sagittarii	16	3	19	2
X Sagittarii	16	4	19	1
T Vulpeculae	16	9	17	18
S Sagittae	18	12	21	22
η Aquilae	18	21	21	3
Y Sagittarii	19	14	21	9
Y Ophiuchi	19	23	26	4
W Geminorum	19	23	22	14
W Virginis	20	1	28	5
T Vulpeculae	20	19	22	4
δ Cephei	20	20	22	11
U Aquilae	22	8	24	12
β Lyrae	22	9	25	11
U Sagittarii	22	21	25	20
X Cygni	23	2	29	21
X Sagittarii	23	4	26	1
W Sagittarii	23	15	26	15
ζ Geminorum	25	4	30	4
T Vulpeculae	25	6	26	15
Y Sagittarii	25	8	27	3
η Aquilae	26	1	28	7
δ Cephei	26	5	27	20
S Sagittae	26	21	30	7
W Geminorum	27	16	30	7
β Lyrae	28	20	Sept. 1	5
U Aquilae	29	9	31	13
U Sagittarii	29	25	1	14
T Vulpeculae	29	16	31	1
X Sagittarii	30	5	3	2
W Sagittarii	31	5	2	5
δ Cephei	31	13	2	4

New Variable Star 5.1902 Lyræ.—In *A. N.* 3783 Mr. A. Stanley Williams announces a new faint variable star in R. A. $18^h\ 56^m\ 12^s$, Decl. $+37°\ 18'.7$ (1855). "All the observations up to the present time are photographic. The photographic magnitude of BD $+37°.3299$ (9.0) was assumed to be 9.0, and the magnitudes of 7 fainter stars were carefully determined from ten plates by sequence of steps. On the adopted scale the magnitude of BD $+37°3311$ (9.5) is 10.15, and that of a faint star 2′ preceding the variable is 11.83. The following are the observed photographic magnitudes of the variable: 1899, Sept. 28, 12.08; Dec 31, 12.05 (a doubtful trace only); 1901, Sept. 15, 12.05; Nov. 2, 10.86; Nov. 4, 10.66; Nov. 5, 10.80; Nov. 15, 10.63.

"The variable is absent altogether from eleven plates taken in 1900 between Sept. 2 and Nov. 22, although most of them show stars down to the twelfth magnitude. Having regard to the invisibility of the star in this year, and to its visibility in Sept. 1899 and in the latter part of 1901, it seems not unlikely that the period is about two-thirds of a year, and in this case the next maximum should occur in or about the month of July of the present year.

New Variable Stars.—Three new variables have been found during the measurements for the Astrographic Catalogue at the Royal Observatory, Greenwich; they are as follows:

Variable.	R. A. 1900.0.			Decl. 1900.0.		Mag.
	h	m	s	°	′	
6.1902 Draconis	18	05	09	+65	56.9	9.0 — <14
7.1902 Draconis	18	06	54	+66	08.9	9.5 — 14
8.1902 Camelopardalis	5	49	22	+74	30.8	8.9 — <14

Maxima and Minima of Long Period Variables.

[Computed from Chandler's "Third Catalogue" by Misses Ida I. Watson and Helen M. Swartz of Vassar College Observatory.]

Maxima.			Maxima.		
Date.	No.	Star.	Date	No.	Star.
July			Aug.		
3	5237	R Bootis	24	5677	R Serpentis
5	1717	V Tauri	25	6905	R Sagittarii
6	4315	R Comae	26	4816	V Virginis
6	4557	S Ursæ Majoris	27	8600	R Cassiopæe
10	7431	S Delphini	28	5593	W Libræ
11	8597	V Ceti	31	513	R Piscium
14	1222	R Persei	31	7252	W Capricorni
14	7468	T Aquarii	Minima.		
15	5037	RR Virginis	July		
17	434	S Piscium	1	1761	R Orionis
19	7754	W Cygni	5	8290	R Pegasi
21	4521	R Virginis	6	5583	X Libræ
21:	7944	T Pegasi	6	5955	R Draconis
22	4847	S Virginis	7	4596	U Virginis
24	5887	V Ophiuchi	8	3493	R Leonis
26	3060	U Cancri	9	1855	R Aurigæ
28	5644	Z Libræ	10	2742	S Geminorum
28	5830	R Scorpii	11	4826	R Hydrae
29	2735	U Canis Minoris	16	5190	R Camelopardalis
29	2780	T Geminorum	18	243	U Cassiopeæ
29	5795	W Scorpii	21	7299	U Cygni
30	2539	R Canis Minoris	27	7659	T Capricorni
30	7779	S Cephei	31:	6943	T Sagittae
31	3994	S Leonis	Aug.		
Aug.			5	2213	η Geminorum
1	7045	R Cygni	9	112	R Andromedae
3	5950	W Herculis	9	7085	RT Cygni
4	7455	U Capricorni	15	7242	S Aquilae
5	7220	S Cygni	16	5194	V Bootis
6	6624	T Serpentis	22	845	R Ceti
8	7733	Y Capricorni	22	3825	R Ursæ Majoris
15:	7260	Z Aquilæ	24	1623	T Camelopardalis
17	715	S Arietis	30	2684	S Canis Minoris

The Proper Motion and Parallax of Nova Persei.—In *A. N.* No. 3789 Professor Ernst Hartwig, of Bamberg, gives the results of six sets of heliometer measures for the parallax of Nova Persei. He used for comparison stars BD + 43°.768 and a star 14^s following BD + 43°.715, their distances from the Nova being respectively about 3019″ and 2970″, on opposite sides of the Nova and nearly in the direction of the greatest effect of parallax. The measures were made on the dates Mar. 4 and 24, Sept. 6 and 8, 1901, Feb. 4 and 5, 1902. The results show no effect of proper motion, but yield a parallax of 0″.16. which corresponds to a distance of about 20 light years.

In *A. N.* 3792 Professor Hartwig announces an error in his calculations and makes the parallax — 0″ 16, which indicates that the 9.5 magnitude comparison stars are nearer than the Nova and leaves the distance of the latter undetermined.

OBSERVATIONS OF NOVA PERSEI.

Eastern Standard Time.					Jul. Day.	Comparison.		Mag.
y	m	d	h	m				
1902	2	3	8	30	2415784	*l* 2½ V 3 *m*		7.56
"	"	4	7	10	85	*l* 2½ V 3 *m*		7.56
"	"	5	9	45	86	*l* 2 V 3 *m*		7.58
"	"	9	7	20	90	*l* 2½ V 3 *m*		7.56
"	"	10	8	15	91	*l* 2½ V 3 *m*		7.56
"	"	11	9	20	92	*l* 2½ V 3 *m*		7.56
"	"	15	7	50	96	*l* 2½ V 3 *m*		7.56
"	"	"	8	5	"	*l* 3 V 3 *m*	2d obs. moonli't	7.59
"	"	18	7	35	99	*l* 3 V 2½ *m*	Very bad seeing	7.60
"	"	19	8	0	2415800	*l* 3 V 2 *m*	Very bad seeing	7.64
"	"	24	7	45	05	*l* 3 V 2½ *m*		7.62
"	3	1	8	0	10	*l* 2½ V 2½ *m*		7.59
"	"	6	7	45	15	*l* 4 V 1½ *m*		7.70
"	"	10	7	20	19	*l* 4 V 1 *m*		7.73
"	"	18	7	0	27	*m* 2½ V 2 *n*		8.33
"	"	23	7	5	32	*m* 2½ V 1½ *n*		8.40
"	"	25	7	15	34	*m* 2½ V 1 *n*		8.47
"	"	26	7	10	35	*m* 2½ V 1½ *n*		8.40
"	"	31	7	10	40	*m* 3 V 1½ *n*		8.43
"	4	9	7	30	49	*m* 4 V 1 *n*		8.54
"	"	13	7	15	53	*m* 3½ V 1½ *n*		8.46
"	"	15	7	20	55	*m* 3 V 1½ *n*		8.43
"	"	19	7	55	59	*m* 3 V 1½ *n*	Moonli't sky hazy	8.43

F. E. SEAGRAVE.

The star *l* is DM + 43°720, *m* is DM + 43°766 and *n* is DM 43°744.

H. C. WILSON.

GENERAL NOTES.

Our readers will please notice that this number of our publication is for June and July, the last named month being one of the summer vacation months. The large space given to tables is necessary for notice of the useful phenomena that occur during the two months.

Some of our correspondents may be disappointed not to see other important articles in this issue. They are deferred on account of lack of space. They will be published later.

Occultation of W Leonis.—On April 16, 10^h 33^m 31^s local mean time, I observed the occultation of W Leonis with my 3-inch Clarke equatorial, power 75. I was taken by surprise and much interested by a decrease of from one-half to one magnitude for about one-half second before emersion. Later I found that the star was a binary, distance about 0″.6, and position angle 101° (Hall '91). I thought that some of the readers of POPULAR ASTRONOMY might like to know of the next occultation of this star. I note it as July 7, 1902. If the point of contact is favorably situated relatively to the position angle of the star, it may be interesting for those possessing small telescopes to try to detect the change of

color which I did not notice, as my attention was occupied in taking the time of occultation. Latitude of place of observation + 42° 23′ 5″; longitude, W. 4ʰ 44ᵐ 20ˢ. JOHN F. COLE.

CAMBRIDGE, Mass.

The Moon and Thunder Storms.—I read two or three weeks ago the article in the April 1902 POPULAR ASTRONOMY on "The Moon and Thunder Storms," page 252. Was much interested in same and also the one referred to in the February 20 copy of *Nature*. Since that time I have been looking over our thunder storm records here and comparing them with the phases of the Moon. I have examined the records for the past six years taking in the years 1896, 1897, 1898, 1899, 1900 and 1901. In the records here all days were considered thunderstorm days when lightning was seen or thunder heard during the 24 hours. During these past six years there were 159 thunder storm days here, or 26½ days per year on the average. They were divided up as follows in relation to the phases of the Moon:

49	days	when	the	Moon	was	between	New and First Quarter
29	"	"	"	"	"	"	First Quarter and Full.
43	"	"	"	"	"	"	Full and Last Quarter.
38	"	"	"	"	"	"	Last Quarter and New.
159	Total number of thunder storm days in 6 years at Providence, R. I.						

If the Moon has any influence at all in producing thunder storms that influence is certainly of a different nature here than at Sidmouth or Greenwich. The records here seem to show that thunder was heard most frequently when the Moon was between New and First Quarter, and least often from First Quarter to Full Moon. I really do not believe that the phases of the Moon or its position in its orbit has anything to do with it. F. E. SEAGRAVE.

PROVIDENCE, R. I., April 28, 1902.

Aurora and the Zodiacal Light.—Recently we have received two interesting letters from Arthur Harvey of the Toronto Astronomical Society about certain phenomena of the zodiacal light and the aurora. The points presented in these letters are so important that we wish to make quotations from them for we are sure they will interest many readers.

Mr. Harvey says: "In common with others of our Society, I value so highly what Mr. David E. Hadden, of Alta, Iowa, says that I wish to call his attention to one of his notes on page 251 of May POPULAR ASTRONOMY, in which he classes as an auroral beam the curious light seen in England on March 4, 1896, which W. J. Herschel and W. H. Robinson and others supposed to be the zodiacal light, moving to its position in the western sky and the direction of the streak which if prolonged would pass through the Pleiades."

Mr. Harvey would naturally be interested in such phenomena when it is remembered that his discoveries in regard to the sudden changes in the brightness and form of comets and the aurioles around the interior planets occur at the times when magnetic disturbances are taking place on the Earth. This discovery by him is a matter of record at Kiel Observatory, the central astronomical bureau of Europe and other foreign countries. It is also an interesting fact that some European observers have sent to Mr. Harvey three recent cases of sudden changes in the brightness of comets of which two were synchronous with a magnetic storm on the Earth as noted from records of magnetic observations. Mr. Harvey says:

"It is not to be supposed that the contemporaneous effect would always be noticeable, for the Sun which sends us excessive changes of electricity when there is a disturbance within its mass, does not radiate these changes in all directions, but they proceed from one of the active meridians in its equatorial belt and seem to spread outward like a broad beam from a search light. So the same disturbance would affect only the bodies within the expanding beam.

"The zodiacal light is very frequently affected by these excessive solar radiations. There was indeed an aurora visible March 4, 1896, at many places; but that, too, was, like the unusual brightness of the zodiacal light, caused by an electrical discharge from the Sun, as shown by the measurements of the magnets. My curves give the horizontal magnetic force, and there was on March 4, a very low reading indeed. From the position of the beam and the low magnetic reading I conclude, it was an enhanced manifestation of the zodiacal light, as classed by Herschell, and not an aurora as Mr. Hadden thinks.

"On page 276 of the May POPULAR ASTRONOMY it is said, on the evening of March 29, the display of the zodiacal light was remarkable, even clearer and more extended, than ever before witnessed.

"But at the same time, about nine o'clock in the evening, Mr. Hadden saw an aurora beam; see page 249, same number. The two phenomena can not be confounded, for he saw the changing auroral colors, and the motion which distinguishes the aurora, while the observers at Goodsell Observatory thought the phenomenon to be the zodiacal light.

"Such coincidences are not accidental. If there was an aurora at the time of zodiacal light observation no one need trouble the magnetic records, there is sure to have been a more or less severe magnetic disturbance."

These notes were taken from a letter written by Mr. Harvey May 3. On May 16 he further says: "Since mailing my note of the 3d with a memo of one instance in which the brightening you saw and the auroral beam seen by Professor Hadden were synchronous, I have received from Mr. Shepard, director of our Observatory, the daily mean readings of the bifilar for March. There was a depression about the end of the month but insufficient to lead one to expect brilliant auroras. Such aurora as these were would occur on the 25th and 29th, atmospheric conditions being suitable and Moon not too bright, which I suppose it was not, or you would not have seen the zodiacal light

"If we go back a few solar rotations we shall find that the meridian of the Sun which faced the Earth on that 29th of March gave us a slight magnetic depression every time it came into position. I made the rotation of that particular belt of the Sun which influences our magnetic disturbances to be a little less than 27¼ days — (27.24) on the average. That would give us as dates to be looked for, August 22, 1901; September 19, 1901; October 16, 1901; November 12, 1901, December 10, 1901; January 6, 1902; February 3, 1902; March 2, 1902; March 29, 1902."

Following this Mr. Harvey gave the figures for mean horizontal force, for each of these days and those before and after, and draws the curves roughly to correspond. Then he says, "six of the nine have a distinct dip on the day. Number 2 also shows the influence of the power, but there is another solar emission two days before. The ninth, (your day) has a low reading as stated, but that of the day after is a little lower still. Whether or not the very lowest of all was on the 29th I cannot say. I admit that there seems to be rather an agreement in favor of magnetic periodicity than of anything else, except for the testimony of a zodiacal light observer. On the 6th of May we had a meeting of the Toronto

Astronomical Society, and an old zodiacal light observer was present, and reported an observation of the zodiacal light at Bellesville, on April 27 which stretched clearly up to Castor and Pollux; it being the finest display he had seen since 1870. This was just one solar rotation after your observation and it would seem as if the disturbed solar meridian that was brightening the zodiacal light on March 29, the magnetic dip of March 29 and 30, was at work again on April 27. This fact too leans toward periodicity in the zodiacal light."

The Anna Bredikhine Astronomical Prize.—The following announcement of the conditions of a new astronomical prize, founded by Professor Th. Brédikhine, in memory of his wife, is published in *The Observatory* for May 1902 and the *Astronomische Nachrichten* No. 3791:

CONDITIONS OF THE PRIZE FOUNDED AT THE IMPERIAL ACADEMY OF SCIENCES AT ST. PETERSBURG, BY THE ACADEMICIAN TH. BRÉDIKHINE IN MEMORY OF HIS LATE WIFE, ANNA BRÉDIKHINE.

(1). With the interest on a capital of 6020 rubles (about 16000 francs) deposited as a perpetuity in the government bank by Th. Brédikhine, in memory of his wife Anna Brédikhine (née Bologovskoi), a prize has been established for the encouragement of the continuation of the labors of the academician Th. Brédikhine in the investigation of the development of cometary forms from a point of view strictly mechanical.

(2). The prize must invariably be called "The Astronomical Prize of Anna Brédikhine, wife of the Academician."

(3). The prize consists of the biennial income (about 1000 francs) from the fund deposited; it will be reduced by the value of a silver medal intended for the judge. The prize is awarded for the investigation of a large comet, based upon a somewhat extended series of observations taken, preferably, by the aid of photography.

(4). The mechanical investigations of the development of the forms of such a comet must be carried on according to the same plan and with the same exact formulas of the movement of cometary particles which the Academician Th. Brédikhine applied in his works on the comets (see Annals of the Observatory at Moscow 1875-1900 and the Bulletins of the Imperial Academy of Sciences from 1890 on.) Transformations and changes of formulas introduced for the purpose of facilitating calculation will form no obstacle to the winning of the prize.

(5.) All large comets which may appear after the beginning of the year 1902 shall be subject to this research.

(6.) The date for the presentation of the works in competition for the prize is fixed for September 10 (the day of the decease of Anna Brédikhine) on the odd years; and the date of the awarding of the prize is fixed for September 10 on the even years.

(7). The work presented may have (1) either the form of a separate pamphlet, printed in one of the languages best known by astronomers of all nations, *i. e.* in one of the predominating languages in astronomical literature; (2) or the form of an extract from a scientific publication in such a language; (3) or again, a manuscript in such a language may be presented; but the prize will not be awarded until after the printing of the work and after two copies have been delived to the perpetual secretary of the Academy.

(8). Foreigners as well as Russians are admitted to the competition. To this end, one year before the presentation of the work the Academy announces

the prize and its conditions in one of the publications most widely known among the astronomers of all nations (*e. g.*, *Astronomische Nachrichten*, etc.). Asto the judgment of the works, the Academy may entrust that to foreign astronomers known to be competent, as well as to Russian astronomers.

(9). In case the biennial prize for one reason or another should not have been awarded at the allotted time, the same will be held in reserve and when the number of unawarded prizes shall amount to five (*i. e.* to about 5000 francs) the total of the five prizes held in reserve, including the interest on them, and deducting a certain sum necessary for procuring a gold medal for the judge, will be given in the form of a "grand prize" for a sufficiently thorough treatise on all the works of the Academician Th. Brédikhine relative to the development of cometary forms, as well as on the works already printed in conformity to the preceding rules. Such a treatise must contain the comparison of all the numerical results as well as all the generalizations and explanations possible in the condition of physical sciences at the corresponding epoch.

(10). The "grand prize" will also be called the "Astronomical Prize of Anna Brédikhine, wife of the Academician." The conditions as to language and nationality of the authors are the same as for the ordinary prizes, or in other words those awarded biennially.

(11). In case of subsequent formations of such grand prizes, the Academy may, if it think best in consequence of sufficient accummulation of material, announce at any time a competition for the purpose of completing and correcting the above-mentioned treatise, according to the works to which prizes had previously been awarded. In the contrary case the Academy may either increase the sum of the small prizes for a certain number of years, or, by a competition it may award the grand prizes for different researches on interesting problems of cometary astronomy in general, or on the theory of meteoric streams. In all these cases the prize keeps its name and preserves the above-mentioned conditions in whatever concerns the language and nationality of the authors.

(12). After the formation of a capital of five smaller unawarded prizes, the Academy brings, as has been said, to the general knowledge of astronomers the opening of the competition of September 10, making the condition that the works on the appointed subject be presented within the space of two years, on September 10, and that the awarding of the prize be announced on September 10 of the year following the presentation.

(13). On each edition crowned with the grand prize, it should be printed, that it is honored with the "Prize of Anna Brédikhine, the wife of the Academician."

NOTE.—The first presentation of works for the prize will take place in 1903, and it will be awarded for the first time in 1904.—Translated from *The Observatory* for May, 1902 by Isabella Watson.

Chinese Calendar.—Referring to the article of your esteemed contributor Wm. L. Hornsby in POPULAR ASTRONOMY for May, page 230, we would say that the distinguished French linguist and antiquary Mons. De Guignes, from an actual and critical inspection of documents found in the State libraries of the Chinese Empire, obtained the following dates of the reigns of eight of their earliest rulers, which after much careful investigation and inquiry, which he states he has reason to believe to be perfectly authentic and reliable.

How remarkably this is corroborated by, or rather corresponds to the account given in the Septuagint (Alex.) version of the ancient Hebrew scriptures, of

the lives of the first eight post deluvian Patriarchs, may be seen by comparing his list with the one I have culled from that, perhaps too much neglected version, which is the same also as the list recorded by Josephus.

Of course the length of these reigns is something entirely unknown to modern history, yet that they are not to be considered altogether mythical may be also gathered from the fact that they do not deviate very greatly from the length of the reigns attributed to the early Egyptian monarchs. But what would seem to show us that we have good ground for questioning the correctness of the commonly received opinion, that the long reigns accorded to these early kings, is entirely mythical and unsupported by any evidence, is the fact that the Chinese records of the reigns of these first eight kings harmonize so well, both in their individual and their total lengths, with the *excess* of the lives of the first eight post deluvian patriarchs over those of their fathers, as will be seen by the two tables given below.

Mons. Guignes states that the first two books of the history from which his table of these eight ancient Kings was taken, were written about the year 2200 B. C. It is hardly necessary to point out that the *reign* of a king is not to be confounded with the length of his life, being usually the *excess* of his life over that of his father.

A very old Scotch author states that "the first dawn of *authentic* history among the Chinese, commences with the reign of Fohee 2953 B. C.," who is said to have studied the motions of the heavenly bodies, to have built the first towns with walls and to have first distinguished families by appropriate names, he himself being titled by his descendant Tyentsee, "the son of heaven;" and that his efforts were mainly directed to promoting the happiness of his people and the institution of the useful arts of husbandry and building, and to establishing the first elements of letters and of grammar.

I have not space to pursue the interesting subject, which is mixed up with the account of a great aqueous comet which descended upon and deluged a vast tract of country and from which Fohee and his family alone escaped by superhuman efforts; also of his afterwards parcelling out the heavens in regular constellations from whence the Chinese date their astronomical science.

Eight Earliest Chinese Kings.				Post Deluvian Patriarchs, as recorded in Septuagint version.			
Fohee reign began	2953						
Shing Nong	2838	Fohee	115	Shem survived Noah			152
Hoang tee	2698	Shing N	140	Arphaxad survived Shem			38
Shoa hao	2198	Hoang t	100	Cainan	"	Arph.	57
Tchuenhio	2514	Shao hao	84	Selah	"	Cainan	103
Tiko	2436	Tchuen	72	Eber	"	Selah	101
Tichee	2366	Tiko	70	Peleg	"	Eber	69
Yao	2357	Tichee	11	Reu	"	Peleg	130
Shun	2253	Yao	104	Serug	"	Reu	123
			698 yrs.				yrs. 773

But for the short reign of Tichee how remarkably close would have been the correspondence.

E. M. TYDEMAN.

CAMDEN, N. J.

Erratum.—In May number of this publication, page 273, line 13 from top for U Aurigæ read W Aurigæ.